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The Mechanical & Electrical Profession

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The Harrisburg Foundry & Machine Works.

A SYSTEM OF ENGINES AND PRODUCTS OF HARRISBURG FOUNDRY *and* MACHINE WORKS

Established 1857

NINETEEN HUNDRED AND SIX

HARRISBURG, PENNSYLVANIA, U. S. A.

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FLEMING ENGINES
AND POWER FACTORS

ANNOUNCEMENT

There are two reasons prompting the personal nomination of the products of this company, instead of the use of "HARRISBURG ENGINES," by which its machinery has become well known.

First, Because in a growing city, such as Harrisburg, that name is open to use by unscrupulous persons, obscuring both the identity of the product and involving advertisement in confusion, and—

Second, Because the name "FLEMING," for so many years identified with the better class of Engineering practice and determined only upon the policy of producing machinery of honest and progressive manufacture, renders to the public a personal claim for and expectation of honorable dealing.

So long as this name identifies the product of this Company, no misstatements may be feared, and the policy of manufacturing strictly in the purchaser's interest may be depended upon.

WILLIAM R. FLEMING

President.

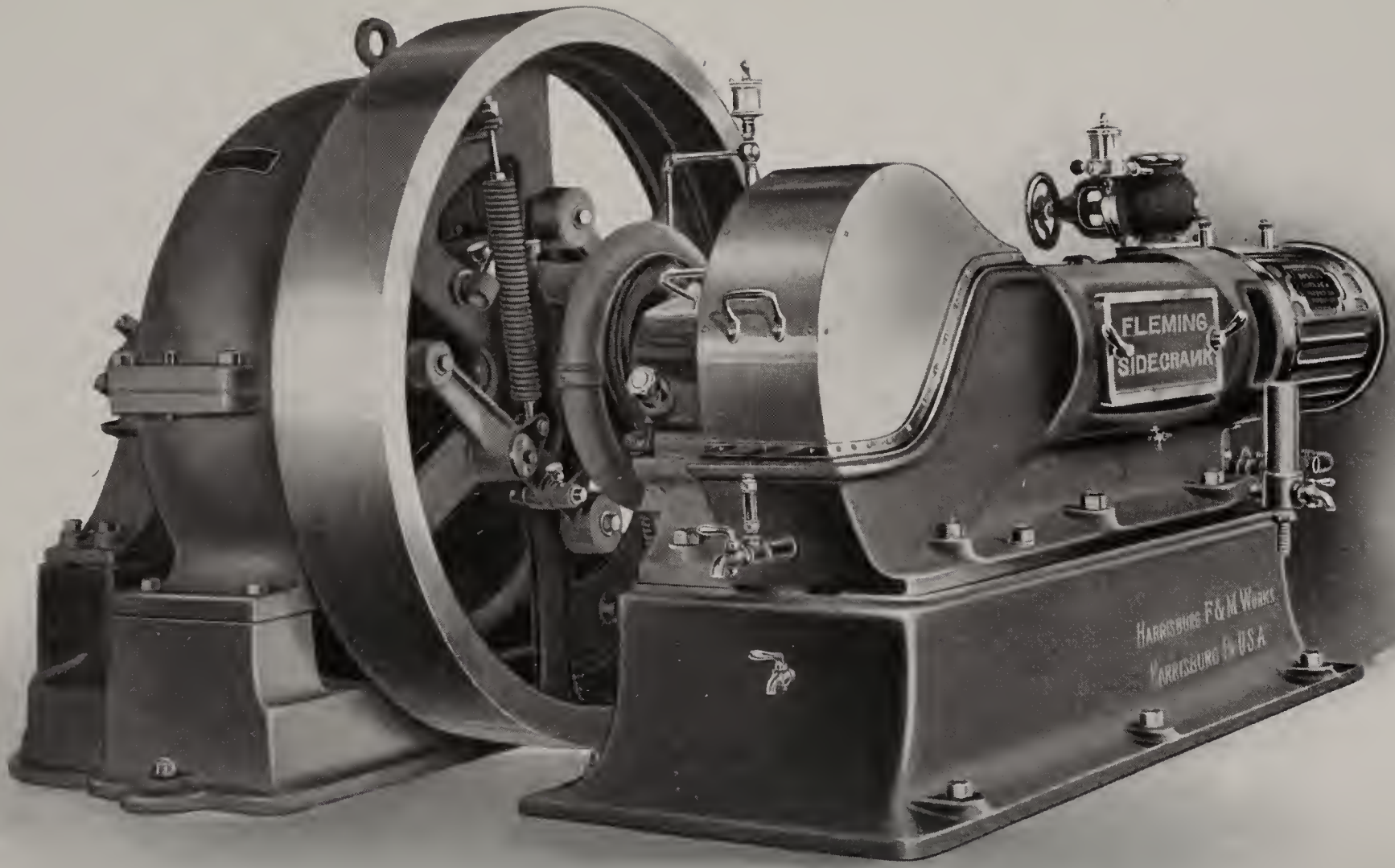

FIG. 38. GENERAL CONSTRUCTION FLEMING SIMPLE ENGINE.
Direct Connected Style, Front View.

THE FLEMING SIDE-CRANK SIMPLE ENGINE

GENERALLY ADVISABLE

It will be generally admitted by those observing, that it is difficult indeed to prove or select the qualities of machinery manufacture by catalogue when each builder usurps the right, whether by "high or low degree," to characterize his products in superlatives and as superior to all others. It may be, the enthusiasm of the chase, is the cause, if not the excuse for this lack of reasonable qualification. At all events, whatever the cause, it is this condition (together with the difficulties preventing *historical* comparison) which often obscures the best judgment of the purchaser and results in an extravagant purchase no matter what the saving in first cost. No one ever hears or sees a machinery representation classed, when offered, as medium or doubtful—all are "guaranteed." Nevertheless, those of experience know that the medium and doubtful do exist and really in the larger proportion and realize, too, that a careless machinery investment works out a short, extravagant life—an impaired asset.

Purchasers frequently prohibit their best interest by limiting the price, at which the competent builders are forced to withdraw and a trifling sum saved (?) at a disastrous cost eventually.

In presenting the products of this Company we have sought to avoid sweeping claims for superiority, preferring to give facts, figures and history, with concise, transparent reasons,—setting forth designs, methods of manufacture and efficiencies, from which to compare and conclude, and upon which we rest our warrant for confidence.

Every engine built by this Company is designed strictly in the interest of the purchaser. We do not claim philanthropy

but expenses on one hand, which might easily be avoided without discovery, are persistently assumed by us if warranted by experience, while useless expense, economic production and close margins of profit are as conscientiously practiced on the other. This policy will not produce cheap machinery, but will surely result in the purchaser's better investment and we believe will continue to add to the reputation and stability of our business.

It is to the keen and broad-minded buyer, therefore, we depend upon for endorsement of policy and trade. That such trade we enjoy, may be gathered from a record of more than 9,000 engines aggregating 1,300,000 horse-power in operation and purchased largely by the competent engineer for exacting service, both as to efficiency and long life. The high standing of our customers and their ability to discriminate is a source of great satisfaction to us. A list of these will be gladly furnished.

This Company has manufactured engines for thirty years and has worn one plant out completely in the work. In 1900 it was determined to rebuild. Having always enjoyed a reputation for producing machinery of the first class, both reliable and progressive, it can be easily understood why our claim, that, given the opportunity to relocate, rebuild and re-equip our plant to the best advantage and to destroy all old and improvable models and substitute without restriction, better designs, based upon past experience, our present product must be of unusual merit and interest to the careful investor in power. We extend a cordial and earnest invitation to visit our Harrisburg plant, which will show an unrivalled location and facilities for both economic and accurate manufacture. Situated at the heart of the great coal and iron State, raw materials are obtained with substantial advantage over other localities, at the same time leaving nothing to be desired as a quick distributing point to large centers.

FLEMING ENGINES

We now possess a plant of the most modern character; new and special tools, electrically driven; travelling cranes; compressed air; improved foundry equipment; special constructive labor saving devices; independent heating furnaces and forging plant for producing both large and small forgings from the analized billet; special Brown and Sharpe annealing and hardening furnaces and grinding machinery; new testing device, etc., etc. All tending to insure a modern and absolutely reliable product.

We submit that unlimited fresh facilities and new models by a concern long skilled in the art, must create an influence in the manufacture worth consideration.

There are many offerings of steam engines at prices, notwithstanding our unrivalled facilities and new models for building engines in large quantities, enabling us to sell at the closest livable margins, lower than our own cost.

The conclusion, however, we believe will be patent to any careful investigator.

THE First Type of the System of Engines

THE FLEMING SIDE CRANK SELF-LUBRICATING SIMPLE ENGINE

As heretofore described in previous publications of this Company we claim to have evolved a most complete system of engines to which will be added as rapidly as the art permits steam turbines, and other power factors. This system being fully developed, enables a separate type for suiting each set of conditions, accomplishing the best instead of indifferent results, and a graduated list of steam motors in closely proportioned sizes, so as to comprehend and satisfy the best expectations possible from the simplest to the most complex conditions, and in powers, ranging from 6 to 3000 horse power units. To have accomplished this purpose has required far greater resources than usual and is of great advantage to the purchaser since it affords him an accurate selection from nearly 900 sizes and styles of machines, obtaining the particular one which exactly fulfils his requirements, both as to investment and efficiency. Not within our knowledge can there be found elsewhere so complete an offering in steam motors.

Scope of the System

In drawing attention to Figs. 21 and 22, it will be apparent that the design contemplates the support of the driving pulley and shaft by two bearings, the pulley serving for belt, balance and governing devices.

History has fully proven that this design affords substantial improvements over past practice on account of which we are justified in the large expense necessary for its development. Whereas, 100 per centum of our manufacture a few years since, was in accordance with the accepted center crank style, we are now building 98 per centum of the two-bearing or side crank construction which is under discussion. We condense the features of advantage as follows:—

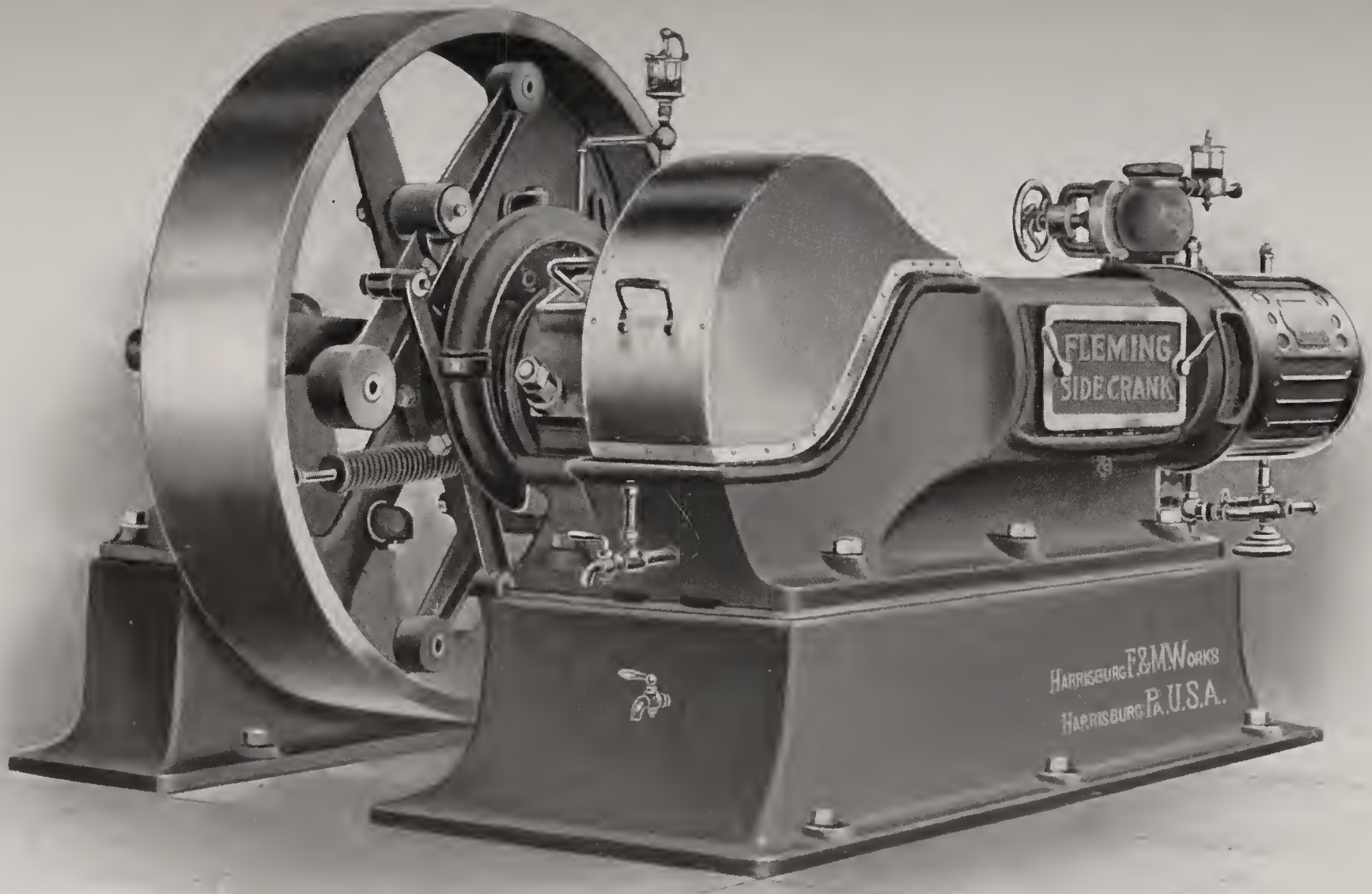

FIG. 21. GENERAL CONSTRUCTION FLEMING SIDE-CRANK SIMPLE ENGINE.
Belted Style, Front View.

THE FLEMING SIDE-CRANK SIMPLE ENGINE

First, The correct maintenance of perfect shaft alignment, which in the center crank is both difficult and uncertain.

Second, The "pull" in a belted unit is equally distributed in the bearings, avoiding the overhanging pulley.

Third, We avoid the third bearing in direct-connected apparatus, saving its friction, attendance and repair. Many would

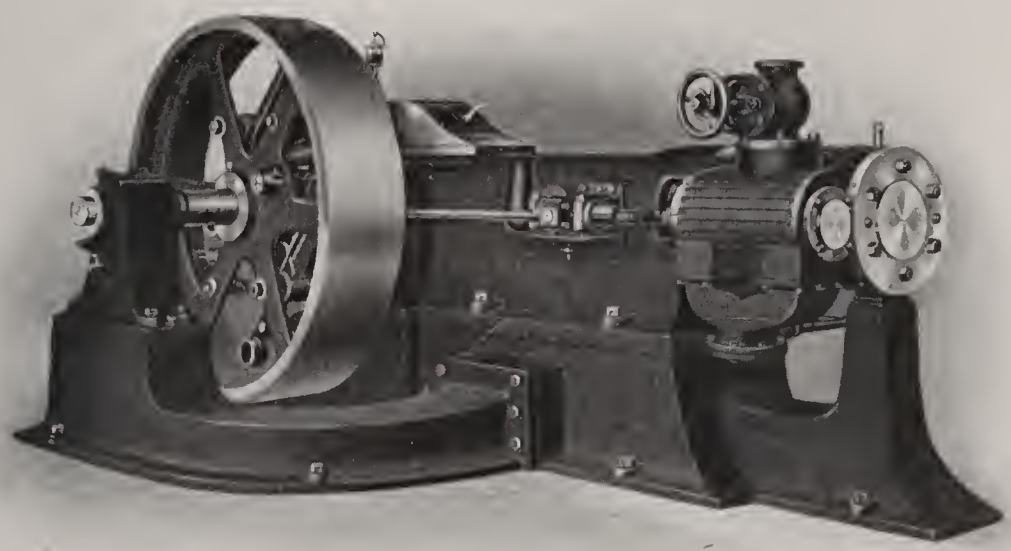

FIG. 22. FLEMING SIDE-CRANK SIMPLE ENGINE.
Belted Style, Rear View.

marvel to learn the great number of *complete shaft failures* of center crank construction, while there appears no record of a single failure in this new design in seven years' manufacture.

Fourth, Improved accessibility, combined with cleanliness.

Fifth, A reduction in floor space.

Sixth, Economy of manufacture, a gain for the purchaser.

This type is built in ninety-five sizes, belted and direct connected, ranging in horse power from ten to two thousand.

AUTOMATIC LUBRICATION

This system is employed in all Fleming Engines upon which such a device could practically apply.

Few Engineers or Purchasers are not now aware how far reaching are the benefits of self-lubrication in Engine practice, and in this respect this Company has had large experience as a pioneer in its introduction. It has been proved beyond question that the life of the wearing parts has been greatly lengthened and the frictional losses of energy are reduced to a negligible quantity by a constant supply of oil positively and automatically supplied throughout the machine. The personal equation of attendance is eliminated; long periods of operation are possible; cleanliness is assured; economy in oil is effected; better speeds are practical; smooth and quiet operation is accomplished. All of these features are substantial gains over past practice. It is, of course, desirable to effect self-lubrication by the simplest method which assures reliability. Long pipes, oil pumps, tanks, etc., involving possible interruption should be avoided. In the patented system which we provide there are no parts necessary other than usual in the Engine itself. A pure mineral oil, which is the only proper oil for all machinery, is poured into the Engine frame, so that the periphery of the crank disc is in contact with the oil. As soon as the Engine is started the revolving disc throws the oil from the reservoir back upon the guides and cross-head, so that these parts and the wrist pin are deluged. The disc also centrifugally throws a continuous spray into a trough placed across the inside of the oil hood, which at once

Description of Self-Oiling Device

Constant Stream of Oil Always Visible

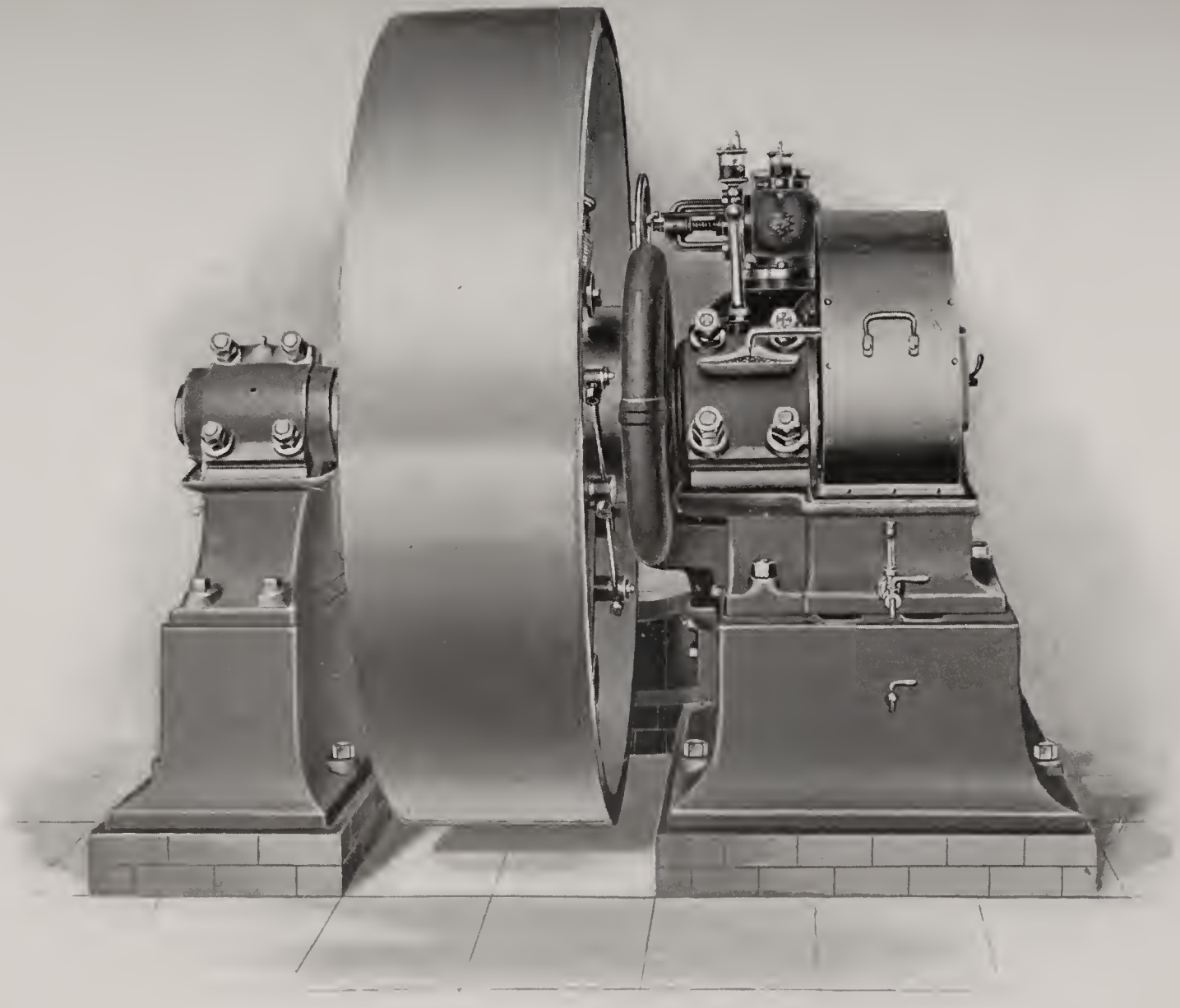

FIG. 24. GENERAL CONSTRUCTION FLEMING SIDE-CRANK SIMPLE ENGINE.
End View, Showing Lubricating Device, Bearings, etc.

THE FLEMING SIDE-CRANK SIMPLE ENGINE

becomes filled. A short tube conveys the oil to a point over the main bearing to which it flows in constant stream always visible to the operator. This oil finds a free passage inward and into an annular *eccentric* groove cut in the face of the crank disc next to the bearing. From the most eccentric point a further passage is provided to the center of the crank pin, in which is providently arranged a hollow reservoir from which the lubricant is ejected to the crank bearing. It will

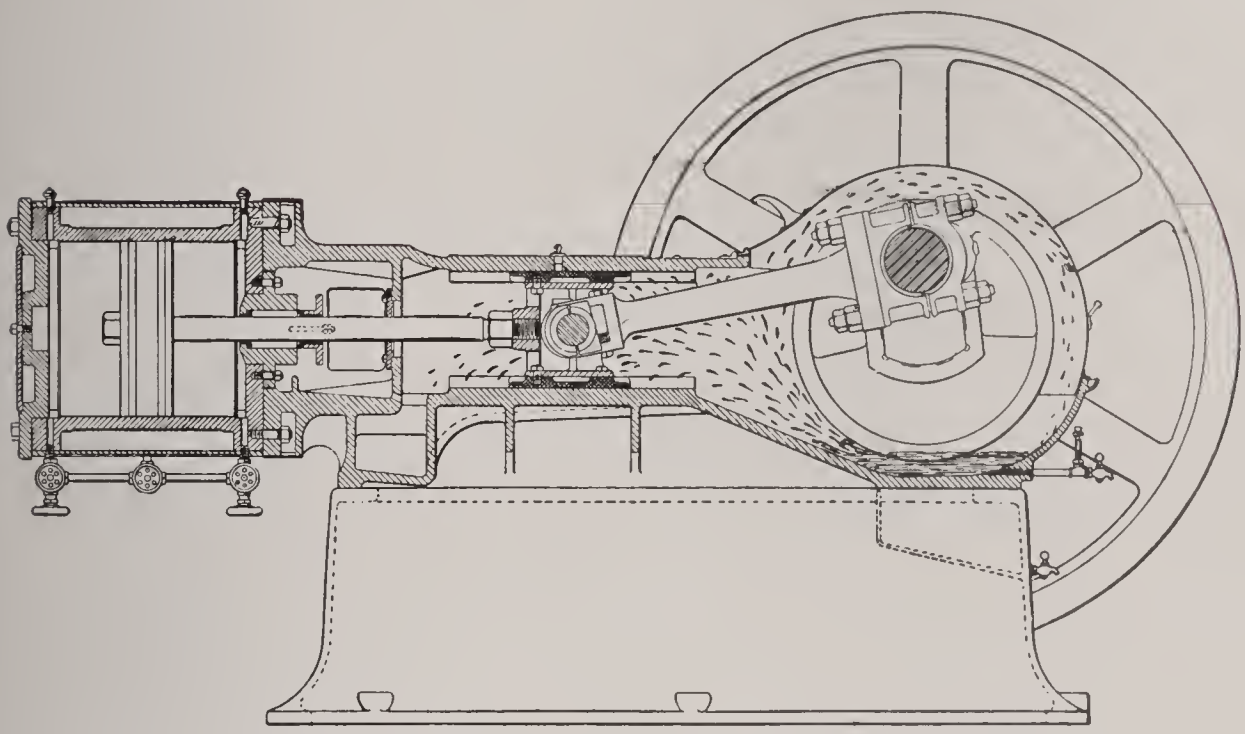

Fig. 2A. Longitudinal Section, showing lubrication.

be seen that this is not a gravity affair, but an unfailing centrifugal oil-pumping system and remarkable for its safety, simplicity, and ingenuity, stopping and starting with the engine. All uncertainties of numerous oil cups or indirect piping are removed, and all that is necessary to the operator is to notice that there is a flow from the trough-tube, which, if disappearing, *must* go direct to the main and crank-pin bearings, the

centrifugal forces drawing through to the crank pin. The guides and cross-head, as stated, are always drenched in oil whenever the engine is in motion.

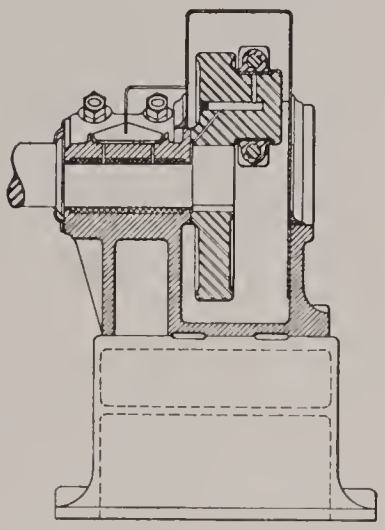

Fig. 2B. Section through Crank and Main Bearing.

While it is true that this Patented Oiling System described is most simple, this simplicity is only attained by costly work on the interior of the important engine parts, so that the device which guarantees to the purchaser safe and economical operation, combined with lengthened life will scarcely be considered only equivalent in value to the cheaper designs of oil pipes and other exterior appliances.

Important to a Purchaser

The best proof of justification lies in the record of many thousand installations and repeated orders from sources from which the best judgment may be confidently expected in steam engineering.

FIG. 12. WHEEL WITH GOVERNOR ATTACHED.
Showing Roll Bearings; also Regulating Speed Weights.

THE CENTRALLY-BALANCED CENTRIFUGAL INERTIA GOVERNOR

CENTRALLY Balanced Centrifugal—Inertia Governor (Patented)

This Company has devoted years of study and great expense to the subject of Governors for Automatic Engines, and notwithstanding the number of devices which are apparently of simple construction and the advantages broadly claimed therefrom, we are, in the light of history, all the more convinced that simplicity is only obtained at the expense of the purchaser's eventual interest in those cases. For usually it will be found that a balance has been sacrificed and we are persuaded that this element is of the greatest importance in machinery designed for better speeds and greater possibilities.

Governor Mechanism

The governors on all Fleming Engines are of the Centrally-Balanced Centrifugal Inertia Type, with two lever arms so located that their centers of gravity are harmonious in action about the center of rotation. This feature in the design insures smoothness of operation under all running conditions of load or pressure and avoids the violent action necessarily in evidence in other governors of less nicety and precision. In stopping and starting there appears no "slamming," or dangerous impact of parts the lightness and strength of this improved governor rendering such disturbances impossible. This governor possesses the ability to control rotative speeds for adaptation to all modern requirements. Both instantaneous and deliberate speed control is obtained so that the exactions of electric service for all systems are met in a satisfactory manner.

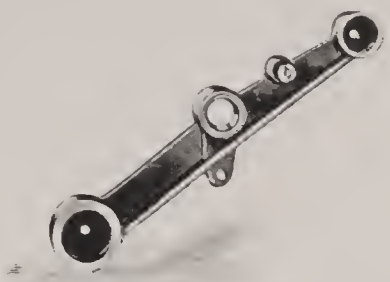

FIG. 17 GOVERNOR ARM

Accurate Regulation

The nearest approach to safety in case of breaking of a spring or its attachments is another advantage gained in this governing design. Should such an accident occur, the engine will not run away. This is an important consideration. The Springs are made of special material and without bent or hook attachments, but designed for a straight pull rendering them almost indestructible. They are made especially for us and will be found safe and unusually durable. All parts transmitting strains are made of steel. The several pins are hardened and ground to gauge, the connecting links are bronze bushed and the main arm bearings are provided with steel rolls, thus preventing as far as possible the danger resulting from the chance neglect of lubrication. A convenient feature is the ease by which a fixed speed may be changed, by a change of weights in the pockets provided at the ends of the governor arms. The eccentric is made of Selected Close-Grained Iron, strong but light, with ample surface to insure indefinite wear. The eccentric strap is also light and strong with ample bearing surface, which is composed of our special Anti-Friction "Fleming" Metal The eccentric rod is forged.

Prevention of Runaways

Hardened Pins Roller Bearings

FIG. 18 GOVERNOR SPRING.

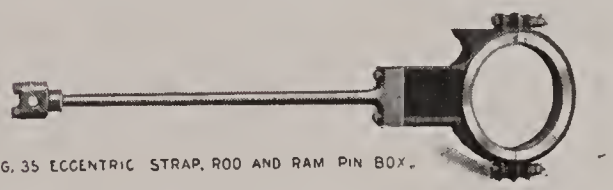

FIG. 35 ECCENTRIC STRAP, ROD AND RAM PIN BOX.

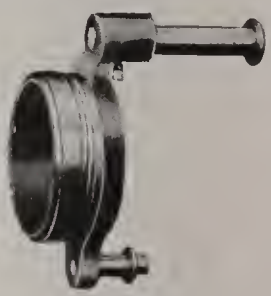

FIG. 13 ECCENTRIC, HANGER AND GOVERNOR PIN.

FIG. 19 ECCENTRIC OIL GUARD

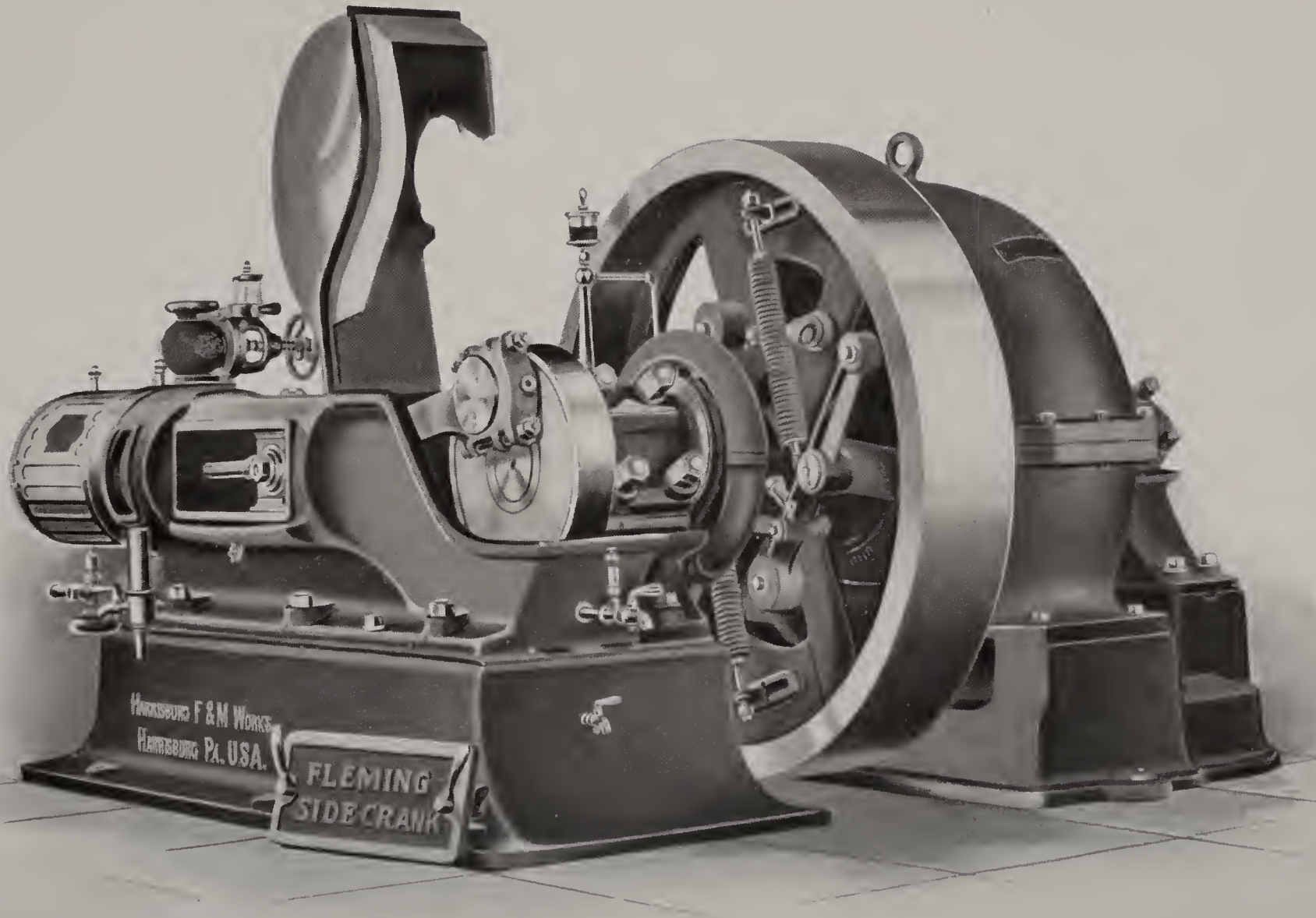

FIG. 23. GENERAL CONSTRUCTION FLEMING SIMPLE ENGINE.
Direct Connected Style. Front View. Showing Accessibility.

THE FLEMING SIDE-CRANK SIMPLE ENGINE

VALVES AND IMPORTANT DETAILS

Importance is naturally attached to the subject of suitable valves for an engine. In considering this matter there should be four results sought for: Efficiency in the distribution of steam; maintenance of efficiency; facility in re-establishment of efficiency and minimum of lost energy. In the design of an Engine its general purpose to the purchaser should be continually kept in mind. It would serve no good purpose to design an elaborate valve, with its necessary gearing, adding expense all along the line, if the purchaser required only a simple, well-built, smooth-running machine of moderate cost. In considering the subject of valves at this point therefore we are referring to their adaptation to the simple, durable Engines of single valve design, the more elaborate, costly and economical styles succeeding under separate headings.

A Valve of the Best Composite Features

From experiment and observation of many years we are more convinced than ever that the best general results, referring to the four objects above named as being essential elements of desirability, are obtained from the modern Piston Valve operating in removable Bushings or Cages. There are, in fact, more successful examples in clever, well-made steam Engines of this design than any other, and it is our belief that there would be little or no discussion upon this point were it not that the Piston Valve, being so simple in form, tempts many builders to resort

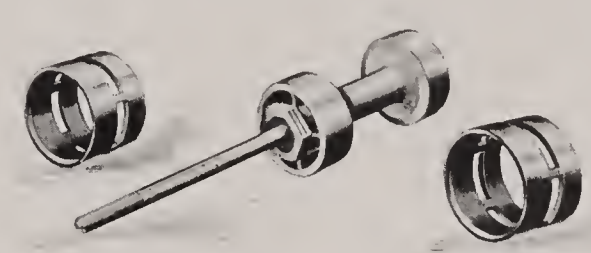

FIG. 20 ADJUSTABLE VALVE AND BUSHINGS.

to improper materials and very scant quality and time in workmanship. Good economy, with quick inexpensive repair, is the essence of the subject and herein lies the cause for our selection of the Piston Valve.

Perfectly Balanced Valves

The selection of proper material for both valve and cages is a vital matter. The use of an open-grained, or porous iron, carries with it its own destruction, and we find carelessness or a disposition to save in cost of manufacture is the cause of most failures. In the Fleming Engines a specially selected, clean, close-grained, hard iron, chilled in casting, is used, which predisposes to glazing in operation and lends itself to accurate surface grinding. Both valves and cages are ground perfectly to fit and are absolutely steam tight, so that, with ordinary care, they will remain so for a number of years. There being no friction whatever other than the weight of the valve to cause wear, and being invariably in perfect balance as regards steam pressure, economical results may be depended upon.

Systematic Provision for Renewal

FIG. 6 PISTON AND ROD.

The port openings in the cages are not the common cored holes, but special milling cutters are passed through each to insure standard production and accurate steam distribution. No care is, therefore, omitted to make a fine piece of work in this important matter, and further, we undertake a careful micrometer record of each case whereby duplicate valves and cages may be obtained with promptness and assurance of accuracy. A quick repair. Our experience convinces us that the practical, sufficient ability to furnish a renewal which may be applied by the purchaser *without loss of time* to the service of the Engine, best gratifies him. In no other valve can this object be so completely accomplished.

The Pistons of Fleming Engines are the result of many years of practice. It's construction is easily understood from the accompanying illustration. It is made in the nicest proportion to secure lightness as a reciprocating part and yet resists all reasonable strain. An improved type of rings and attachments are used which have been found excellently adaptable to this type of Engine and are far superior to ordinary "snap" rings, which are, of course, cheaper.

Superior Pistons, Rings and Rods

Particular attention is drawn to the quality of material used in rods, the cost of which exceeds the cost of the usual rolled steel by three times, and is that adopted by the builders of the highest type of locomotives. The larger sizes of Engines are equipped with Phosphor Bronze "Bull" rings.

IMPORTANT DETAILS —FORGINGS

It is our belief that insufficient attention is paid to the quality and character of the forgings used in Engine construction. The practice of ordering from a large steel mill finished forgings not only renders the promise of machinery delivery by the Engine Builder unreliable, but an entire absence of knowledge as to quality of the forgings so obtained—their proper tensile characteristics—suitability to respective purposes—freedom from flaws, etc., is practically unavoidable. The importance of these considerations is so plain to us and the purchaser's interest so frequently neglected by the uncertainty of employing proper material, that we have been to great pains to better provide suitable forgings in Engines of our manufacture. To this end we proceed to control the material problem by the purchase of the billet upon chemical analysis, deliberation being always possible by carrying an ample stock in that form, while the proper manufacture of the forging is accomplished by having Heating Furnaces and Steam Hammers identical with those of the great Steel and Iron Mills, but proportioned to our needs. The certainty of thus controlling the quality and forging of the wrought materials of a Steam Engine is no idle question and when it happens that both are to be had without additional expense in those respects from this Company, we are led to believe our methods will continue to be appreciated by the best class of buyers. In our best practice the

Forging from the Billet the Only Safe Way

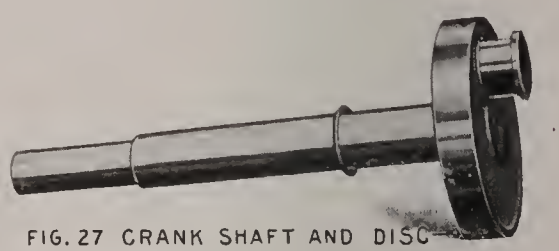

FIG. 27 CRANK SHAFT AND DISC BELTED STYLE.

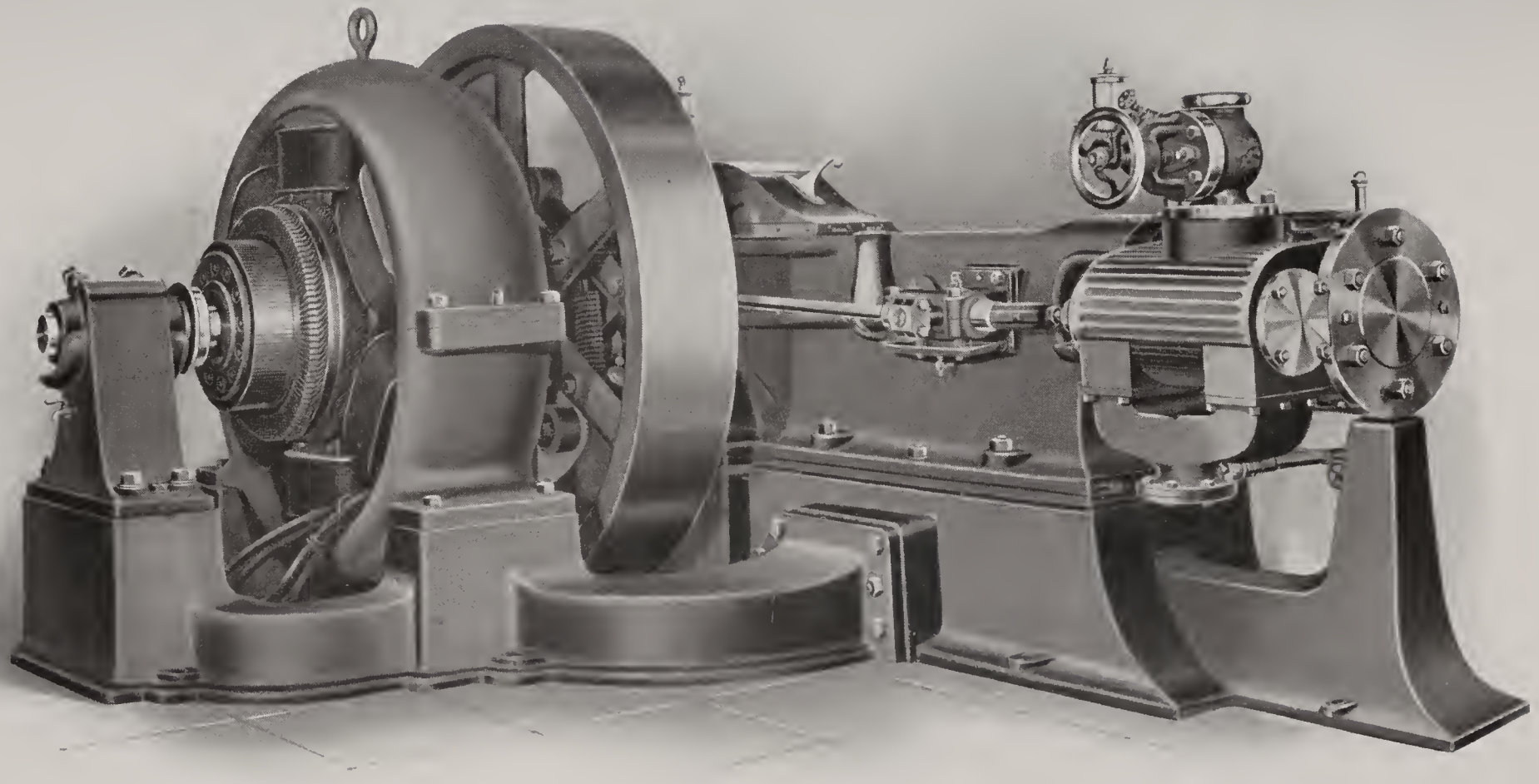

FIG. 39.—GENERAL CONSTRUCTION FLEMING SIDE-CRANK SIMPLE ENGINE.
Direct Connected Style, Rear View.
NOTE: Engines 16x15 and larger built with substantial cylinder support as shown.

THE FLEMING SIDE-CRANK SIMPLE ENGINE

Engine Crank Shaft is a straight steel forging having special characteristics, in ductility and tensile strength, wherewith to resist sudden shock and at the same time to resist tendency to crystallization. Many shafts are running perilously near the breaking point because of the lack of these requirements, and shaft failure is both dangerous and expensive.

A Remarkable Crank and Crank Pin (Patented)

Attached to the shaft is a crank of simple form and yet of unusual construction. The material used is of our own production and unknown to the trade, containing as it does, both steel and iron. The purpose is to obtain necessary strength to insure against all usual hard usage and to have a Crank Pin which will better resist wear from abrasion than in other practice. In construction the Crank and Pin are in one piece, thus avoiding the chances of improper fitting in older designs, making "square" and true machinery easy and perhaps, best of all, getting the most strength at the point of greatest effort. It will also be apparent that a larger pin is thus possible so that the wearing is greatly reduced by diminution of abrasive pressure. The pin being hollow results in lightness, strength, certainty of soundness, and the employment of a reservoir to guard against accidents. This general construction was variously commented upon when first produced, but in more than 2,500 Engines now in operation, many in the most severe service, not one failure, coupled with microscopic repairs, best tells the story of a substantial improvement. The illustrations here shown indicate the two forms of Con-

FIG. 28 CONNECTING ROD AND BEARINGS.

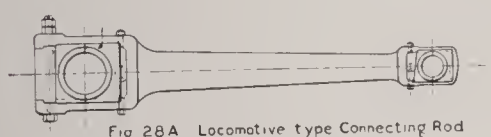

Fig 28A Locomotive type Connecting Rod

necting Rods which we consider best adapted to the service. The "Marine" type is usually used in Engines from 16-inch stroke and below, the "Locomotive" design in larger sizes and in Compound Engines. These Rods are wrought from the best open-hearth steel with solid forged ends for Cross-Head Brasses, and in the "Locomotive" style, Steel Babbitted Crank Box. The "Marine" type has slotted forks for Babbitted Crank Box held by recessed cap and heavy steel stud-bolts with vari-threaded lock nuts and cotter pins.

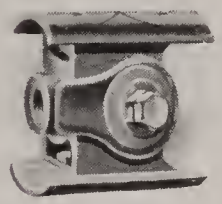

FIG 55. CROSSHEAD AND PIN AND SHOE ATTACHED.

The Cross-Head Pin is also of the best open-hearth steel and made accurate by special machinery, after which it is submitted to the "Brown and Sharpe" complete process of annealing, case-hardening and grinding to gauge. Too much cannot be claimed for the pains and accuracy taken to secure a perfect pin which will endure great stress and wear.

Reliable Wrist Pin and Steel Cross-Head

The Cross-Head is made of a steel casting and equipped, top and bottom, with bronze shoes. It will, therefore, be seen that no expense has been spared to make this a reliable part of the Engine, and we feel sure will appeal to the purchaser in marked contrast with many cheaper designs wherein cast iron is employed or similar effort to cheapen at great risk and at the expense of certain rapid deterioration.

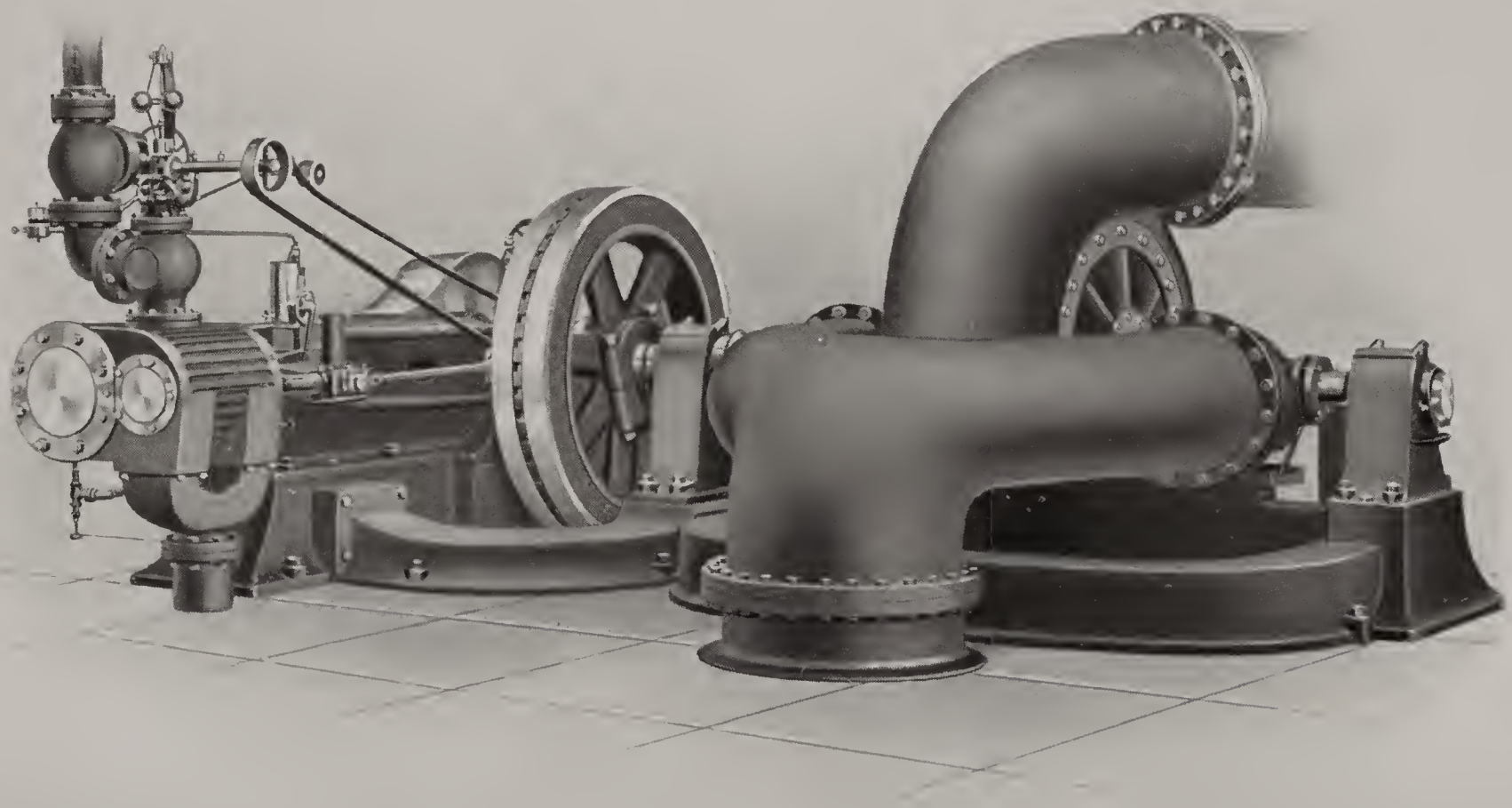

FIG. 83. GENERAL CONSTRUCTION FLEMING SIDE-CRANK ENGINE.
Direct Connected to Centrifugal Pump.

THE FLEMING SIDE-CRANK SIMPLE ENGINE

IMPORTANT DETAILS —BEARINGS

(Continued)

We wish to say something about the Bearings of Fleming Engines. From a long and comprehensive experience we have had many opportunities to demonstrate principles involving the proportions, the lubrication, the endurance and the materials best employed in Engine bearings, and we wish the fact known that in reaching our present practice we have not inclined in the least to cheaper methods, but entirely to those proven by long usage to be the best, almost totally ignoring the element of cost in obtaining a satisfactory result. There come periods within which peculiar practices occur and have a following for a time, but there can be no safer teacher than experience, especially when accompanied with the closest observation of other experiments than our own. The special material we use as a lining for bearings is the highest cost, but the results warrant its use from the purchaser's standpoint, its endurance being beyond all record—"Fleming Metal."

Reliable Bearings of Remarkable Endurance

The Main Engine bearing is designed with great care, of most liberal proportions, and lined with our special "Fleming" metal, hammered into place and accurately bored and scraped to fit the shaft. With the smaller engines this bearing is partly solid with the frame, the upper half being a removable cap, between which and its companion half are placed thin metal liners, which afford a ready means for making any necessary adjustment. We have occasionally furnished a specially designed, removable cast iron shell for Main Bearings,

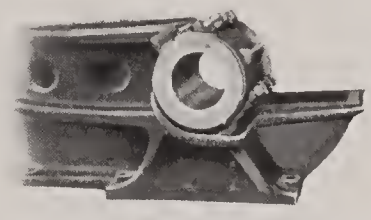

Fig. 86. Angle Box Style Bearing, used with moderate sized engines.

lined with our "Fleming" metal, carefully machined and made to fit the bed cap, the intention being to enable quick removal should occasion arise. This bearing, if built in a very thorough and rigid manner, and so designed that any wear can be taken up, serves its purpose fairly well. It, however, has not shown equal results with the rigid bearings here described, and so it is not furnished except by special request.

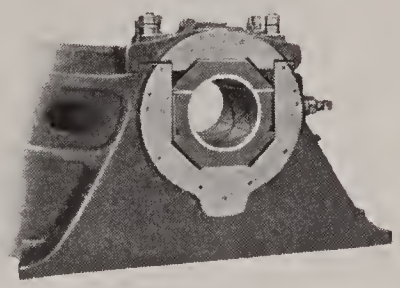

Fig. 87. Quarter Box Style Bearing, used with large sized engines.

Faithful Construction to Avoid Future Repairs

With the large-sized Engines a lined quarter-box bearing of ample size is employed consisting of four parts, carefully machined on all sides to secure rigidity, and accurately bored and scraped to fit. The construction of these shells is such that the bottom piece can be removed by slightly lifting the shaft from its bearing, the other three parts are removed after taking off the cap. Vertical and horizontal adjustment is secured by means of lock-nutted set screws. The outer bearing is identical in design with the main bearing, differing only in the manner of lubrication. With the main bearing the oil flows in a constant stream from the crank case to the bearing, while with the outer bearing the oil is brought to the shaft surface by two or more special bronze, non-magnetic chains.

FIG. 32 OUT BOARD PEDESTAL.

FIG. 34 OUT BOARD PEDESTAL-SHAFT IN POSITION.

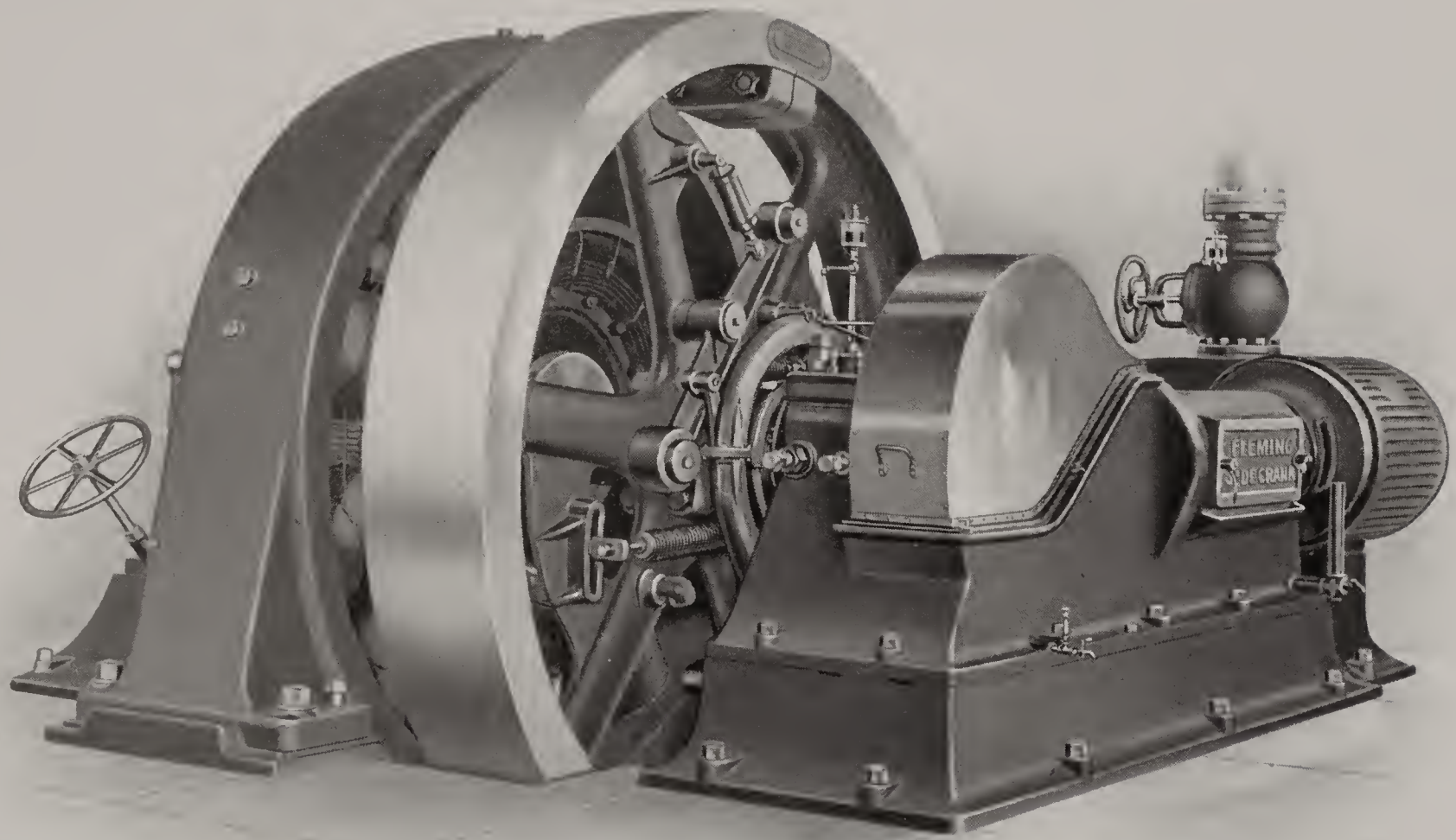

FIG. 81. GENERAL CONSTRUCTION FLEMING SIDE-CRANK ENGINE.
Heavy Railway Type, Direct Connected, Front View.

THE FLEMING SIDE-CRANK SIMPLE ENGINE

DETAILS OF CONSTRUCTION (*Continued*)

Fewer purchasers than ever are now desirous of saving an insignificant sum at the expense of an unattractive Engine. It is now generally admitted that subsequent life and care is curtailed to a much greater extent than a slight saving in first cost warrants. Pursuing this policy to reasonable degree we refrain from furnishing roughly painted cast iron oil hoods which are often in evidence in cheaper machinery. The illustration gives a fair idea both of finish and construction. The hood covers both crank and disc completely, preventing any escape of oil from the crank case and at the same time affords a ready means of access when desiring to make adjustments or examination. This hood is made of the best quality of polished metal, with polished brass angles riveted to the sides and ends where contact is made with the Engine frame. Particular attention is given to the accurate fitting of these parts, so that it effectively prevents any oil from being thrown from the Crank. A special feature is shown in the construction, and which is frequently used, allows the Crank Hood to be raised upward until the center of gravity is thrown backward toward the cylinder, when the whole is supported by a polished brass quadrant, while the clinging oil on the inside of the hood drains properly back into the engine frame. This avoids lifting the

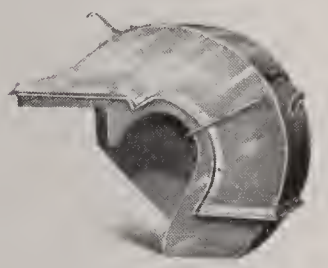

FIG. 29 POLISHED OIL HOOD AND FITTINGS.

Presentable Machinery is Now Considered a More Stable Asset

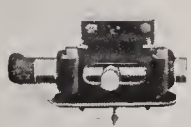

FIG. 30 RAM AND RAM BOX.

hood from the engine with its heretofore dripping oil and the soiling of a cleanly engine room floor.

A feature showing marked improvement in design is that of the Ram between the ends of the eccentric rod and the valve stem. In form this is circular, and *ground to gauge*, having simple and effective means of taking up wear and maintaining noiseless running conditions. The past practice was to make this detail square, a shape subject to inaccurate machine work and unsatisfactory in lubrication. Years of use has demonstrated the practicability of the form shown in assembled illustration, substantial and simple in design. The box is lined with "Fleming" metal and has every means of lubricating the entire surface of contact.

Cheaper Construction only at the Purchaser's Expense

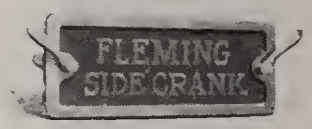

FIG. 31 REMOVABLE NAME PLATE.

Accessibility to the Cross-Head and guides is had by removing a side plate, fitted oil-tight, and held in position by two cam handles, a quarter turn of which releases it. The converse side of the plate contains in raised letters the name indicative of the particular type of Fleming Engine. Directly under this name plate on the engine frame is provided a trough which receives the slightest leakage, prevents its wasteful and unsightly dripping to the floor, and drains it properly back into the interior oil supply.

FIG. 85. GENERAL CONSTRUCTION FLEMING SIDE-CRANK ENGINE.
Heavy Railway Type, Direct Connected Style, Rear View.

THE FLEMING SIDE-CRANK SIMPLE ENGINE

SAFEGUARDS AND SAVING DEVICES

In the case of an abnormal rise in pressure in the cylinder due to defective steam piping or to boilers so constructed as to entrain water to the engine, there is provided, to meet such emergencies, carefully designed relief valves placed at each end of the cylinder. These relief valves, or diaphragms, shown in illustration, are made of specially-tested iron, the bottom being turned to a determined thickness, which will yield and liberate the water if subjected to pressure of about 50 per cent. above the maximum running steam pressure. In design they are simple and cannot become inoperative from disuse. Handsome, well-designed valves are provided for the cylinder, cutting off, when desired, the exploded diaphragm, and making it possible to place a new one in position without shutting down. It is, of course, known that no device of either valves or reliefs can entirely remove the danger or breakage from water which comes into the cylinder in large quantities from undrained pipes, sudden boiler foaming or other causes which will wreck any engine, but these simple devices will be found usually effectual, as indeed, they must be, within the limits of their possibilities. To those who prefer so-called "snifting" or pop valves, they will be applied when so requested or when the type of engine necessitates such. These valves are shown in Fig. 33-A.

FIG. 33 EXPLOSION DIAPHRAGM.

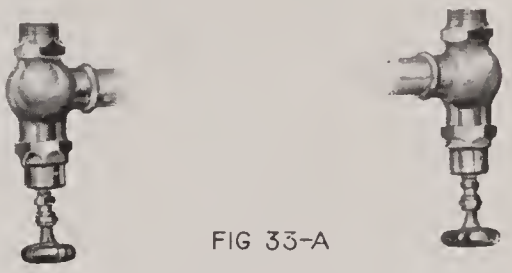

FIG 33-A

SPRING LOADED RELIEF VALVES

ADDITIONAL OIL SAVING —How It Is Accomplished

Separating and saving oil has received thought and attention in the Fleming Engines, and the result, we believe, combining both ingenuity and advantage to the purchaser is considered one of many evidences of superiority over common offerings. This is a patented device and is not found where the privileges are not granted. Description follows: An opening at the lowest point in the division wall provides passage for all condensed water and oil dripping from the piston rod. Both are drained to a receptacle under the guides, as shown in Fig. 82. Water being the heavier, seeks the bottom, purifying the oil in contact. The separator at the side of the engine frame contains an internal tube ("A"), set at such height as will flow the water without attention, while oil thrown by the crank disc drains to its reservoir, for general lubrication, by a channel provided along the guides. But slight attention is necessary to produce results. Occasionally drain the separator to avoid foreign matter by Bibb cock provided. To Adjust: Raise the tube ("A") so that upper end is level with channel along guides. Then while engine is at rest and without oil in crank reservoir, fill the small chamber at end of guides with water to about one inch of top; then, fill reservoir to proper level. After starting engine lower tube a few threads until drops of water appear. Any excess of water will now flow off without oil. Avoid making a tight connection to a drain pipe, but use a funnel as shown, thus the draining process is visible and the taking down of rigid connection unnecessary. This will be found a device of singular usefulness and considerable economy.

Operation of an Ingenious Oil Saver

Simple Instruction for Obtaining Results

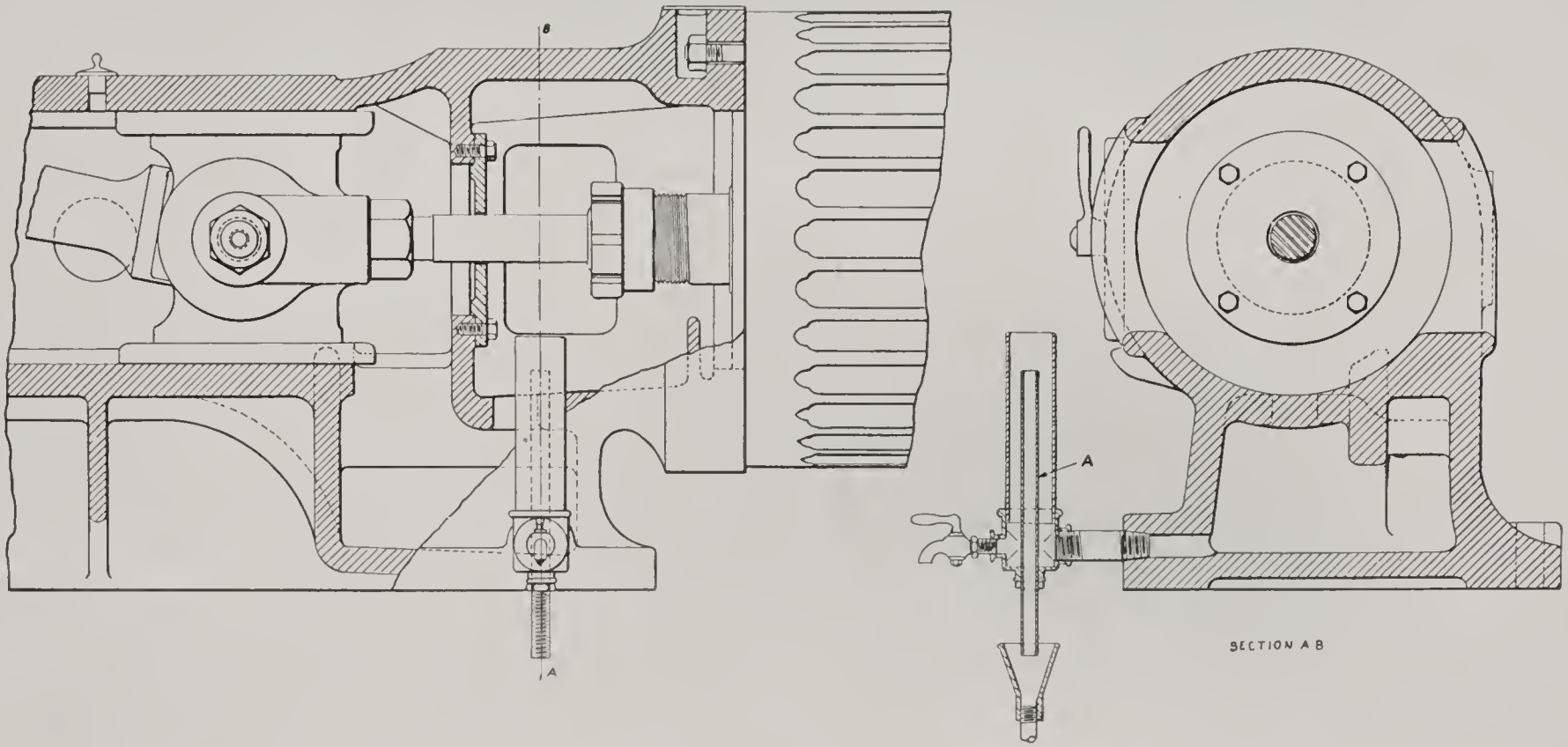

Fig. 82. LONGITUDINAL SECTION, SHOWING OIL-SEPARATING DEVICE.

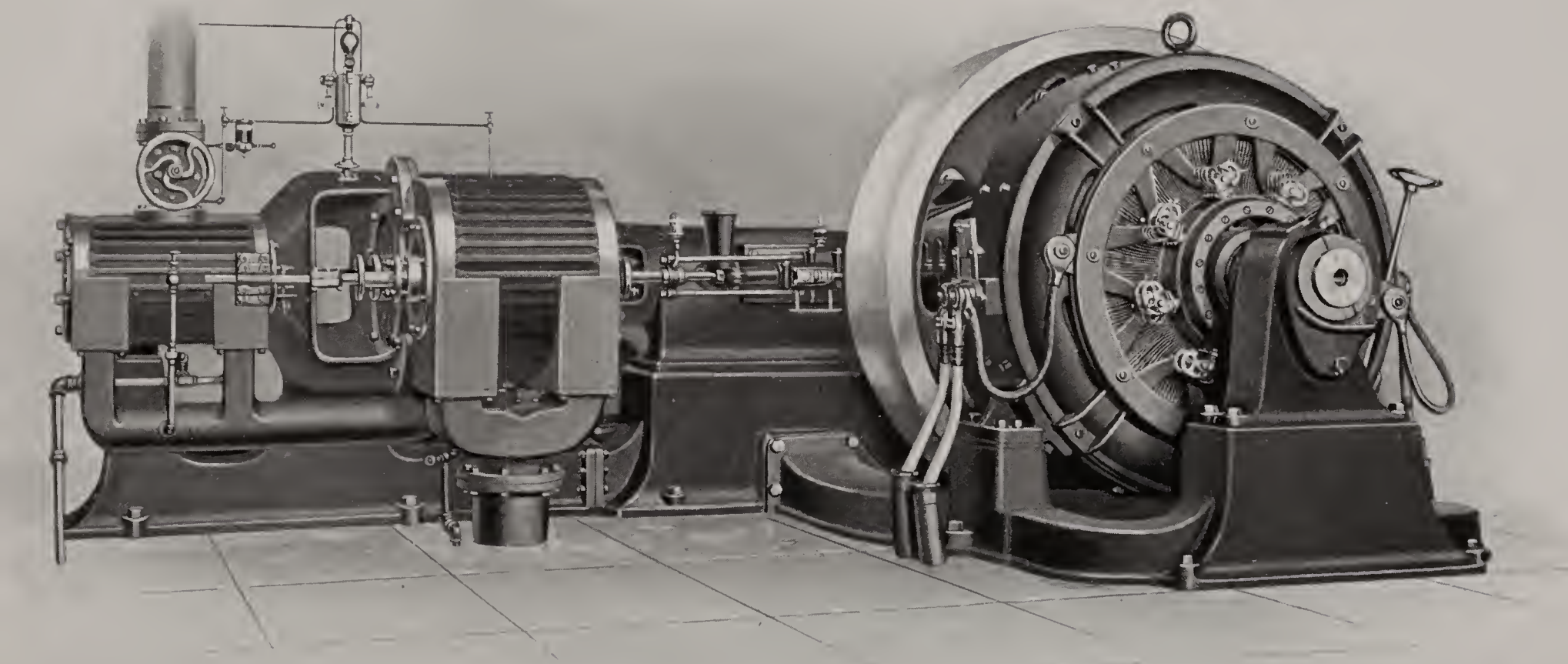

FIG. 88. GENERAL CONSTRUCTION FLEMING SIDE-CRANK TANDEM COMPOUND ENGINE.
Direct Connected Style, Rear View.

THE FLEMING SIDE-CRANK TANDEM COMPOUND ENGINE

THE Second Type of the System—

THE FLEMING SIDE-CRANK, SINGLE VALVE (SELF-LUBRICATING) TANDEM COMPOUND ENGINE

Only a few years since there existed a doubt as to the practicality of a short-stroke, quick-acting, wheel-governing Compound Engine, and their general adoption certainly was retarded by meagre results obtained from unworthy examples. These still curiously find their way into more or less prominent institutions, usually through the attraction of (insufficient) first cost. These doubts are, in our practice, being gradually dispelled through the contrast of properly designed and mechanically correct examples, built regardless of the current prices, but justifying the principle and the investment. The result is that we are enjoying a very large trade, which is steadily increasing in this machinery. Generally speaking, these Engines will show an advantage of quite twenty per cent. over the same Engine with single cylinder. And, this becoming known, serious consideration is natural. The conditions producing best results and which justify the considerable greater outlay, are as follows: Expensive coal, a factor; intelligent attendance, important; steam pressure, controllable within 115 to 150 pounds; size of units from 75 to 1,200 Horse Power; maximum advantage in case condensing is possible. The saving, is, of course, measured by the smaller amount of steam used per horse power, this bringing the corresponding saving in fuel. Between the two types these results may be compared: Simple engines, 28 to 30 pounds; compound engines, 21 to 25 pounds—both non-condensing. If condensing facilities of 26 to 28 inches of vacuum are available, the compound engine will result in 17 to 20 pounds of steam per horse-power hour. Thus the type deserves serious thought.

The Warrant of Investment

Conditions Assuring Splendid Results

DETAILS OF CONSTRUCTION

In the original design and subsequent improvement of this Engine, the objective, and we think apparent purpose, was not to produce a machine which could be manufactured at little cost nor on the other hand prove costly in manufacture, but rather to embrace the important features in which the user would find durability, economy, accessibility and the comfort resulting from a good machinery investment. Most engines of this kind are built with scant regard to any real claims to these elements and but little analysis is necessary to determine the fact that unless properly designed and constructed they will prove exceedingly costly, whatever their first cost, in a few years of disappointing retrogression. Our first consideration of construction is to provide and insure the most substantial attachment of the low-pressure cylinder to the engine frame. In no other construction can this be so well accomplished, as is shown, although perhaps a more expensive method.

Designed to Avoid Deterioration

Next we provide a generously proportioned cylinder connection, made with side openings ample to provide easy access to both stuffing-boxes and in internal diameter sufficient to allow the removal of the low-pressure piston. This must certainly appeal to the engineer or purchaser as most desirable. Careful provision is made to provide against malalignment as well as expansion and contraction. Any lifting tendency is further controlled by a slot and cap bolt between the two surfaces, and it is obvious that the objectionable "overhang" which less substantial methods show have no place in this design. To attempt any cheaper method would only postpone expense.

Generous Provisions to Avoid Later Expense

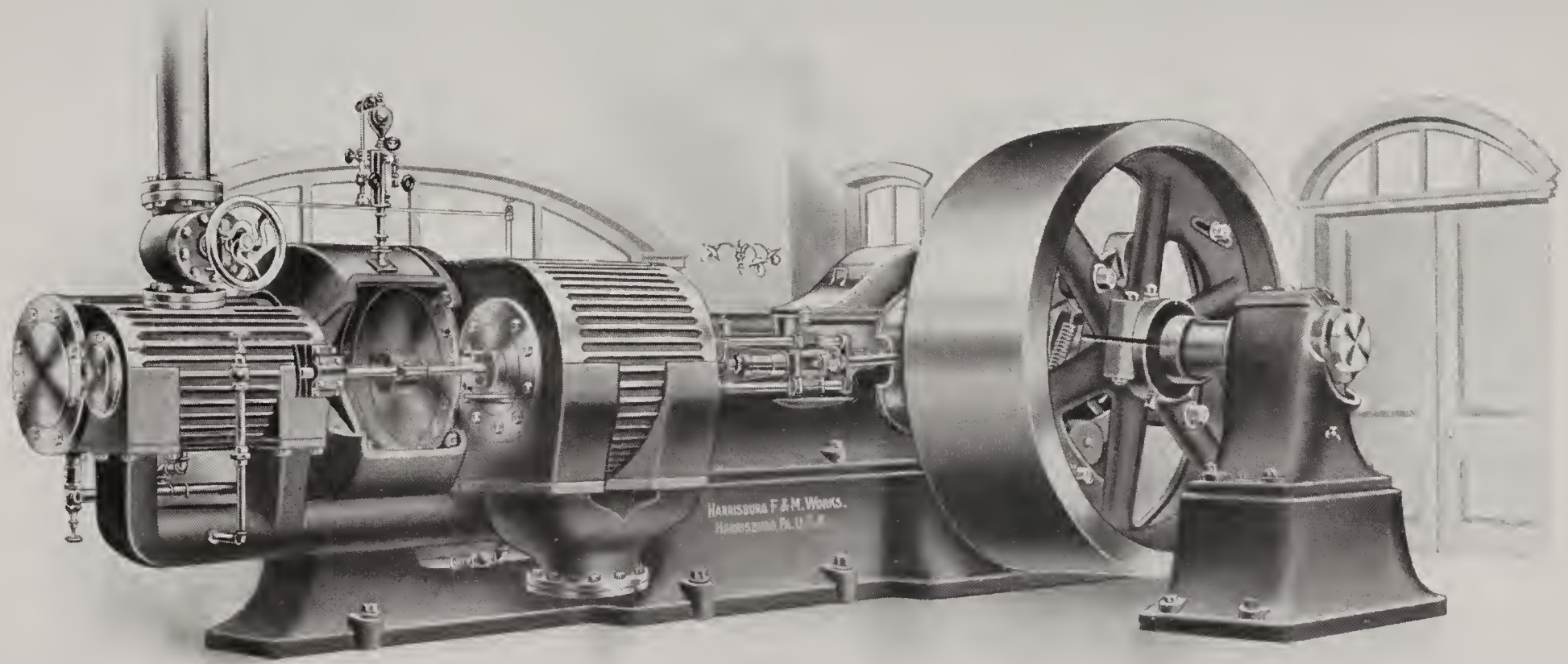

FIG. 41A. GENERAL CONSTRUCTION FLEMING SIDE-CRANK TANDEM COMPOUND ENGINE.
Belted Style, Rear View.

THE FLEMING SIDE-CRANK TANDEM COMPOUND ENGINE

DETAILS OF CONSTRUCTION (*Continued*)

It will be seen that self-lubrication of the engine is provided as in all Fleming Engines, permitting its use, and from its effects are gained a material saving in frictional losses running up to a sum usually surprising the engineer, a marked reduction in repairs and a cleanly presentable engine at all times. The description of its operation has been described under special heading upon this important subject. The receiver between cylinders is also constructed in a substantial manner. A neat flanged casting, not made of common pipe and cheap fittings which add numerous and troublesome joints always liable to leakage and consequent impaired economy.

Self-Lubrication Saving Friction and Repairs

Figure 40 illustrates the second type of the system of average size. The smaller sizes have both high and low-pressure valves controlled by one eccentric, actuated by the Centrally-Balanced Centrifugal-Inertia Governor, described under special heading upon that subject. The larger sizes are built with two separate eccentrics, the high-pressure being automatic and the low-pressure having a hand-adjusted fixed eccentric. This arrangement has been found by us to accomplish the best average results and has become standard manufacture.

A further advantage is found in providing piston valves with adjustable heads. These allow "lead" and "lap" capable of change to suit any changed conditions rendering a more flexible machine both for service and as an asset or exchange.

A Valve Adjustment of Great Advantage

This type is built in sixty-eight sizes, belted and direct-connected, ranging in horse power from twenty-five to three thousand.

THE Second Type of the System—

THE FLEMING SIDE-CRANK, SINGLE VALVE (SELF-LUBRICATING) CROSS COMPOUND ENGINE

Floor space is usually the main condition upon which a selection is made between tandem and cross styles of compound engines. We wish, however, to call a little closer attention to the distinctive capabilities of the Fleming Cross-Compound as an aid to the purchaser.

Distinction of Character in Design and Finish

The same care in design, character and distinction in the proper use of materials and workmanship are employed as upon other types of the System. In the matter of efficiencies under most conditions, they are practically identical with those frankly given in describing the Tandem Engine, and which we believe to be better than can be obtained from any comparable steam motor. There are mechanical features, however, which lend the cross style to some services to advantage. We claim, by reason of carefully worked out and ingenious refinements, that the Fleming Cross-Compound Engine gives improved steam distribution resulting in improved efficiencies and almost uniform effective effort on both pistons throughout the whole stroke.

Features Giving Uniformity in Speed and Results

Thus we fully satisfy the latest electrical requirements of alternating generator service, for, properly controlled at the high-pressure side by the nicety of the Centrally-Balanced Centrifugal Governor (described under separate heading) and fixed adjustable eccentric at the other, we undertake to control rotative and varying speed satisfactorily and without further adjuncts.

For convenience or desire, we apply both mechanical and electrical speed changes also, but we make note that good results

may be had in the Fleming Engines without them. Other features of some moment are: Availability of one-side operation in case of emergency by disconnecting one rod; general accessibility to the principal engine parts; slightly greater friction and increased engine and foundation cost. These machines are strong, durable and well-finished, capable of heavy and continuous service with little attention and of maintaining an unequalled curve of efficiency under changing loads or pressure.

THE Third Type of the System—

THE FLEMING SIMPLE (SELF-LUBRICATING) FOUR VALVE (CORLISS) ENGINE

In presenting this type of the Fleming Engines, it is felt that we are indeed describing a design of remarkable and really unparalleled accomplishment. Originally built, now (1905) seven years ago, it was intended to take a modest position between the best economies obtainable from the Single or Multiple Valve Automatic Engine and the best type of old-style Corliss Engines. Its success now places it far beyond the possibilities of both. We realize that these statements may be questioned until investigated, but after tests, records and history are examined no further doubt can reasonably exist. These engines mark a new era in power development. One may search authentic records of net efficiencies throughout and fail to find results from any steam motor equalling those now realized and guaranteed from this thoroughly demonstrated factor in steam power.

Superior to Any Other Steam Motor

Careful investigation is invited. The claims made for superior results are quite unusual and interesting. There are now in actual operation nearly 200 of these engines, of which none built during the past three years has been changed in design, showing the conception to be thoroughly beyond experiment. It may also be of interest to know that in our own establishment have been made, tested and compared the finest type of long-stroke Corliss Engine which, in comparison with the Fleming Engine, was found to be vitally inferior, considering efficiency, frictional losses and regulation. Particularly is the long-stroke Corliss Engine outclassed upon varying loads.

Investigations and Comparisons Invited

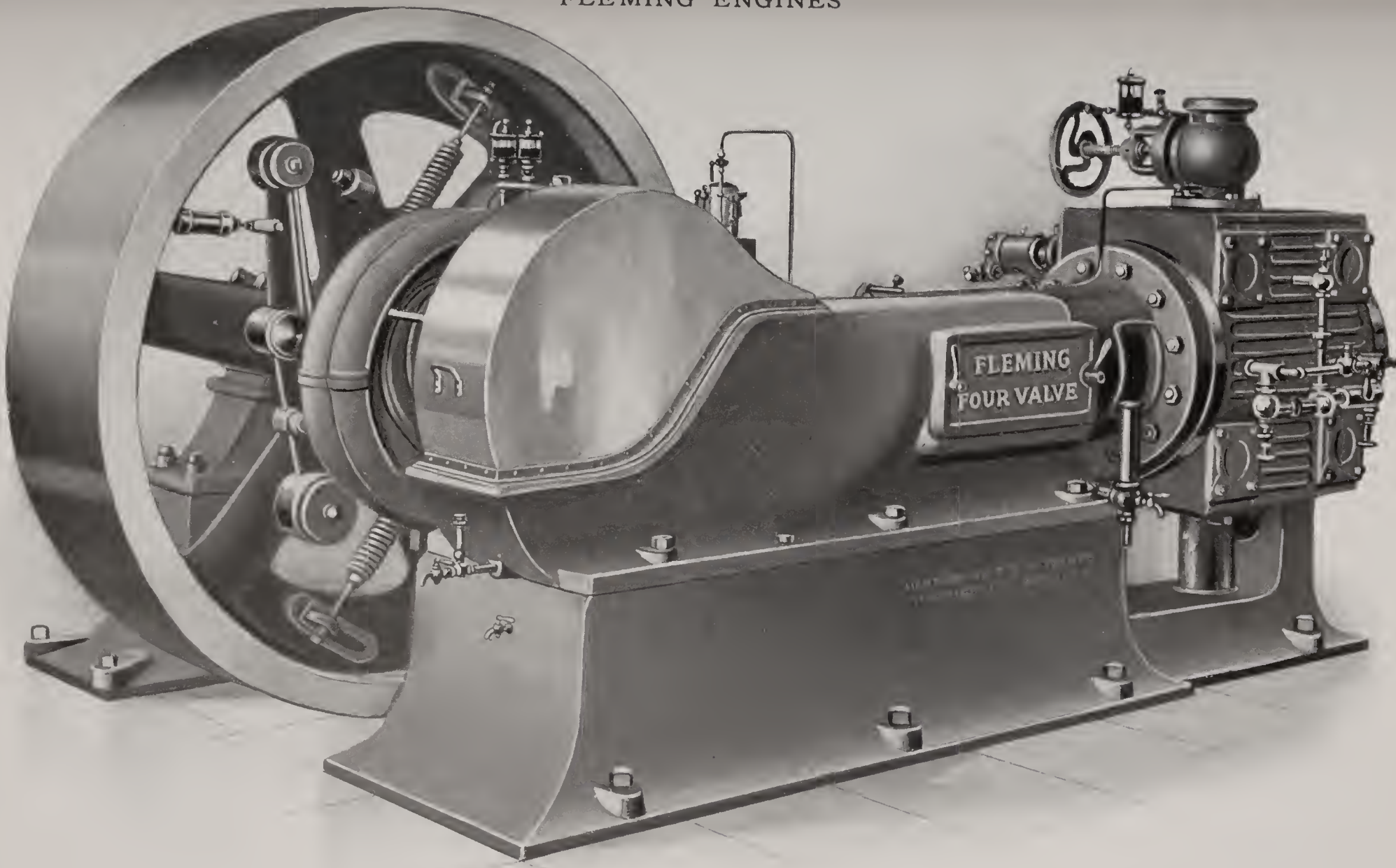

FIG. 42. GENERAL CONSTRUCTON FLEMING FOUR-VALVE SIMPLE ENGINE.
Belted Style, Front View.

THE FLEMING SIDE-CRANK SIMPLE FOUR-VALVE ENGINE

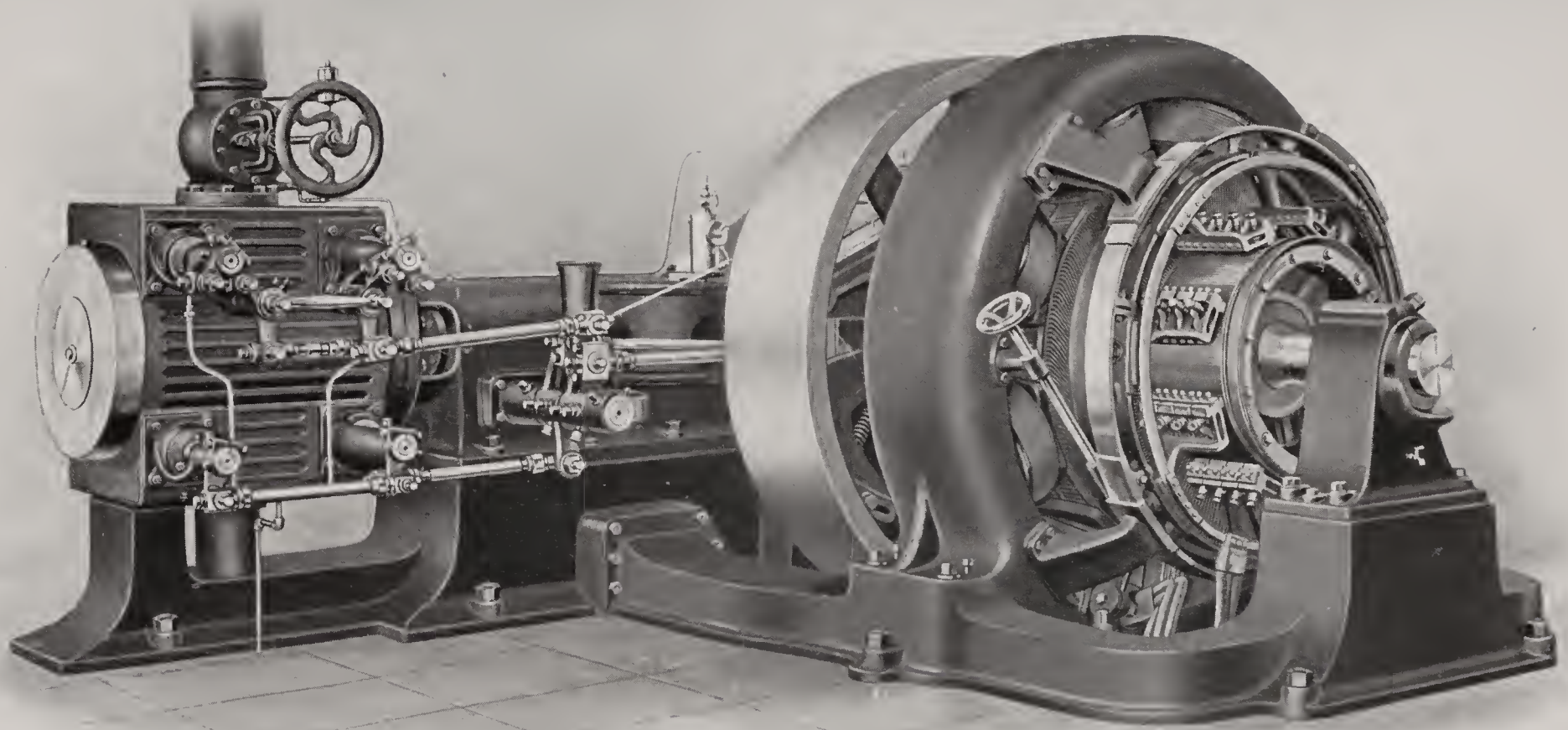

FIG. 89. GENERAL CONSTRUCTION FLEMING FOUR-VALVE SIMPLE ENGINE.
Direct Connected Style, Rear View.

THE FLEMING SIDE-CRANK SIMPLE FOUR-VALVE ENGINE

APPLICATION, Expectations and Construction

A revolution of the established principles, upon which steam engineering is based, is not claimed, but it will be found that with fewer complications than ever before, without auxiliary cutoffs, dash pots, wrist plates or the like, at more advantageous speeds, accomplishing complete automatic lubrication, decreased floor space, faultless regulation, noiseless operation, we are yet able to accomplish the lowest records of economical steam consumption, which means corresponding gain in fuel. Although at an increase in cost over single, double, telescopic, four-ported or three-valve examples: The Fleming Four-Valve (Corliss) Engine will prove a better investment and asset, and is less expensive usually than a single-valve compound engine with which it closely compares economically.

Surprisingly Simple When Carefully Studied

We illustrate in Figs. 42 and 89 the general construction. The conditions producing the best results are as follows: Coal, fairly high cost; intelligent, obedient, but not skilled attendant; steam pressure, 70 to 130 lbs. initial; units from 75 to 1,800 horse power. Advantages: Compact floor space; highest efficiency; self-lubrication; reduced frictional losses; closely uniform efficiency under wide power fluctuations; quiet running; a clean, beautiful mechanism. Results, economically, as fine as 23 lbs. of dry steam per horse power per hour may be obtained if fair pressure is available. Such are the remarkable attainments of these engines, and their qualifications have justified their selection in many of the best-known and modern plants in America. It need not

A Simple Engine Giving One H.P. on 23 lbs. Steam Per Hour

be said that the most careful selection of materials (not idle claims), workmanship and fine finish are employed. Samples are upon exhibition at all our Branch Offices. The principal difference in construction from other types of our manufacture occurs in the design and construction of cylinders, valves and their gearing wherein their ingenuity results in new records for efficiency.

We desire to say that we observe a number of imitations appearing in competition. These we have investigated and fall far short in essentials and will usually be found to contain features which have been tested by our longer practice and found either very undesirable or an absolute detriment to the complete possibilities of this unique example of modern power factor.

DETAILS OF CONSTRUCTION (*Continued*)

Two eccentrics are provided, one actuating the two-steam admission valves, controlled by the Automatic Centrally-Balanced Centrifugal Inertia Governor (described under separate heading) and the other driving the two exhaust valves, fixed and independent, arranged, however, to co-operate most effectually. The motion of both valves is conveyed from their respective eccentric to bell-cranks by independent rocker-arms. Upon projecting arms of the steam-valve brackets are mounted bell-cranks coupled together by adjustable links. To the short arm of this bell-crank is attached a link which transmits the motion to a valve-arm secured to the projecting valve-stem.

Valve Motion of Remarkable Simplicity

The valve, being thus oscillated by the compounding of the angularity of the several levers, gains the advantage desired in accelerated motion at the point of opening and closure, and without the complications of older practice. The exhaust valve-arms are connected together by a common link imparting the proper harmony of motion to both.

Triple Valve Acceleration Without the "Accelerator"

It will be seen that triple acceleration is obtained by the simplest means, *i.e.*: Eccentric movements, with a result of the most advantageous steam distribution. To this improvement and refinement in steam distribution is due the reduction in steam consumption and the "knowing how" is the purchaser's justification of confidence.

We are applying experiment and engineering talent of the highest order to problems in steam theories in which but scant attention, if any, is employed elsewhere. All of this with its

tangible results are reaped by those entrusting their requirements to our hands, while differences in guaranteed results as well as first cost may be easily accounted for if time is taken for investigation.

An Important Word Regarding Efficient Speeds

There will be found no mysteries, or inconsistencies if this be done. No cast iron is used in the valve gear, every piece is of selected material: bronze, steel, etc., and thoroughness in providing adjustment of the best kind will be found everywhere.

Rocker-arms are crucible steel with bronze adjusting shoes; all bearing pins are treated with Brown and Sharpe hardening and grinding processes to gauge; link and other boxes are of bronze with shoe adjustment with lock-nut; internal force lubrication is provided, all evidencing a character and grade of workmanship far beyond the best practice of the past. By these means and because of an accomplishment in smooth operation we have overcome any reasonable objection to improved speeds. We say *improved* speeds because many good engineers are not aware that most careful experiment and test show that lower speeds seriously impair economy.

Prompt Ability to Adjust Valves

There is nothing whatever to prevent our following low-speed design except that it violates a demonstrated principle and prevents the owner from realizing our best guarantees. We build the Fleming Engines for the best speed mechanically and economically, and can easily demonstrate this to be the correct principle if our records are studied. Connecting valve-links are made with right and left-hand threads, insuring prompt adjustment with precision. The valve bracket with stuffing-box attached, is designed so as to form a neat drain for attaching polished drip tubing. The steam valves—the results of extraordinary patience and test—perform, with unique success finally accomplished. Slightly unbalanced, three-ported, perfectly

tight, yet requiring little power to drive, they will continue infinitely to wear well and maintain economy, positively seating because of resultant pressure. Early points of cutoff are amply obtained without excessive angular movement, and a range secured from 0 to about ¾ stroke during which the curve of efficiency is most remarkable. Ranges of power from one-third to one and one-quarter capacity frequently show less than 1½ lbs. difference in the steam used. It is well known that other machines have not shown such results. The steam valves are bushed so as to provide inexpensive repair; an addition to first cost, but in the user's interest. The exhaust valves are single in the smaller and double-ported in the larger sizes. The material used in both valves is especially made and must be seen to be appreciated. Summing up we may say that this type of Fleming Engine is a revelation to engineers who have seen earlier or other attempts to solve the Multiple-Valve Automatic Engine without success. The problem is now solved, and frankly, even beyond our own expectation. We, therefore, confidently invite investigation of tests too copious for publication here.

Uniform Economy With Varying Power

This type is built in eighty different sizes, both belted and direct-connected, and range in horse power from seventy-five to twenty-five hundred.

THE Fourth Type of the System—

THE FLEMING FOUR VALVE (CORLISS) TANDEM COMPOUND ENGINE

From the description given under separate heading of the simple Four-Valve (Corliss) Engine and the proof assured for its extraordinary operation, it may be reasonably expected to hear something unusual as from the compound style of this new steam power factor. Our claims will not, we think, be disappointing. We are taking another step forward in economies. Additional expense is involved in its attainments, but results fully warrant it. The success of this engine lies entirely in the *superior efficiencies obtained,* together with a grade of construction which renders its *durability at better speeds an establishment.* In earlier practice this was but partly true; now it is accomplished. Nearly four times as many engines of this type were built in 1904 than in the year previous, which was currently our largest year's output.

Difference in Cost a Wise Investment

The conditions producing best results are as follows: Units from 100 to 2,000 H. P.; pressure if non-condensing, 120 to 160 lbs., if condensing, from 110 to 200 lbs.; fuel, expensive; steady or varying load; close regulation. Under favorable conditions a steam consumption fully equal to 12 lbs. per I. H. P. will result, condensing, and as low as 17 lbs. non-condensing, and both without superheat. Two points must be borne in mind to appreciate the remarkable character of this engine: First, that loads in service almost always fluctuate and, that nothing within our knowledge will maintain such *uniform efficiency* even when pressures also vary, and Second, that after frictional losses are charged, its *net efficiency* compares even more advantageously.

Points in Economy Frequently Lost Sight Of

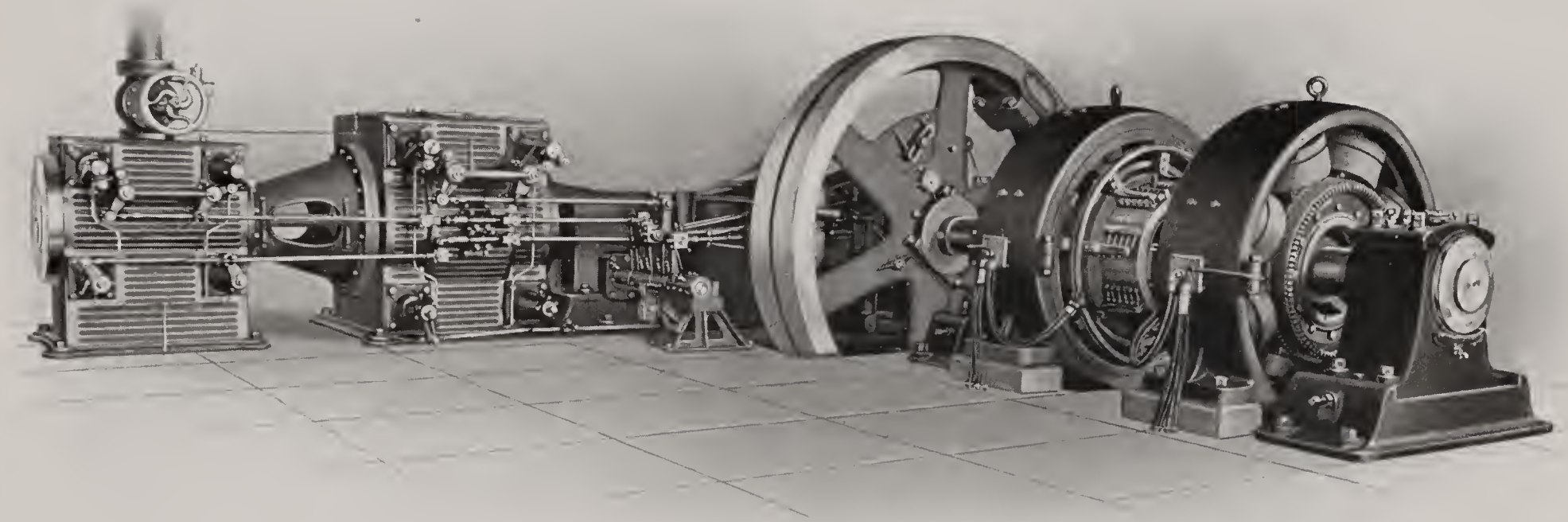

FIG. 93. GENERAL CONSTRUCTION FLEMING FOUR-VALVE TANDEM COMPOUND ENGINE.
Direct Connected Style, Rear View.

THE FLEMING FOUR-VALVE TANDEM COMPOUND ENGINE

DETAILS OF CONSTRUCTION

These Fleming-Corliss Engines are the result of seven years' practice and while new to many are far from new to ourselves. They are built for *hard work* and *highest efficiency,* and it must be known also that they are built for *speed* and *pressure.* Purchasers frequently stand directly in opposition to their object by restriction in these matters.

Purchasers Often Prevent Best Results

They intend, of course, to practice conservatism, but if our full experiments were known to them they would see at once their mistake. Our policy, we repeat, is in the purchaser's interest, and is to put the money into quality to withstand speeds, wear and pressure, giving the warrant in record of *new efficiencies* and *low repairs*

Our advice is to practice your conservatism in paying for quality and insist upon the maker producing results. Neither durability nor best economy can possibly be realized at prices less than that which such machinery *should* cost. The obscurity comes from the bugbear of saving (?) in *first* cost. Our construction, therefore, is unquestionably of the highest grade. No hair-splitting or ambiguity, but absolutely the best. All cannot be described in a catalog treatment, but our proposals contain it, leaving no room for doubt or dispute, and far more minutely than usual in common practice. In Figs. 93 and 59 we illustrate two Fleming-Corliss Tandem Compound Engines of moderate size. Attention is called to the generous size and get-at-able design of the connection between cylinders in Fig. 93. This is also made with tongue and groove method of providing for expansive movement and alignment be-

Our Proposals are Definite

tween it and its sub-base support, as shown by Fig. 59. This sub-base is frequently omitted to the users' detriment in other offerings and will account for lower prices when omitted. Self-lubrication is also provided, which has far-reaching advantages.

Our illustrations show quite clearly the valve gear. Three eccentrics, which admirably actuate all the valves are provided. The high-pressure valves are controlled by the governor, while an adjustable cut-off eccentric serves to operate the low-pressure steam valves, thus giving a flexible arrangement and providing for any apportionment of the load desirable. This type is built in sixty-four different sizes, both belted and direct-connected, and ranging in horse power from one hundred to three thousand.

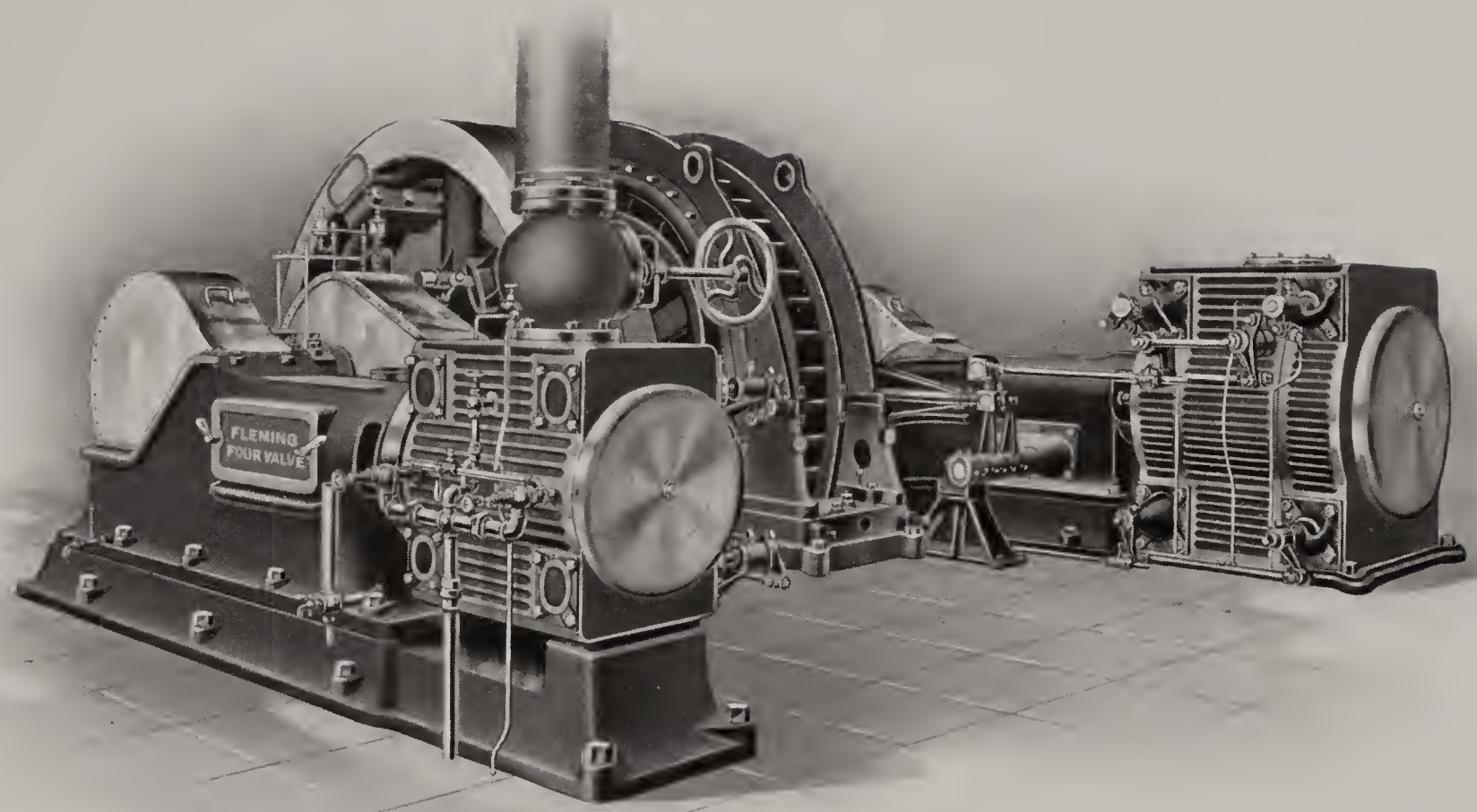

FIG. 60.A. GENERAL CONSTRUCTION FLEMING FOUR-VALVE CROSS-COMPOUND ENGINE.
Direct Connected Style.

THE FLEMING FOUR-VALVE CROSS COMPOUND ENGINE

THE Fourth Type of the System—

(Continued)

THE FLEMING FOUR VALVE (CORLISS) CROSS COMPOUND ENGINE

Under the Tandem Engine of this same type we have carefully described in considerable detail the remarkable success of these very modern and highly-efficient machines, giving results in economy, conditions wherein they best operate and general construction advice which essentially apply to the cross-compound style here illustrated by Fig. 60-A. Repetition, therefore, is unnecessary in those directions. There are, however, several mechanical advantages in some services which the Cross-Compound Four-Valve Fleming Engines offer and which will be of interest to know. Concretely they are as follows: Designed and constructed on compact, massive lines and combining the most reliable materials with excellent work. The heaviest services required (electric railway, combined motor and light requirements, inertia loads, etc.) are effectually negotiated without noticeable shock or strain, and as stated, without seriously effecting *uniform efficiency*.

Specially Suited to Difficult Service

This ability renders storage battery assistance unnecessary. Another advantage is apparent through an improved valve gear, so nicely developed as to be better controlled and operated by a Centrally-Balanced Centrifugal Inertia Wheel Governor (a far more safe, powerful and stable device than other types of speed regulator). These properties insure correct operation of alternating current installations without surging, undue wear or risk. In spite of varying opinions, and notwithstanding the natural tendencies to cling to older well-known types, these engines are now proving their *superiority* from an engineering and investment standpoint.

Engines Really Superior to Older Types

SPEED-CHANGING DEVICES

In many power plants, where two or more units are in operation and especially where alternating current electrical service is employed, it is considered desirable to provide engines with speed-changing apparatus to operate the various units in exact synchronism, or at precisely the same speed. With an installation of Fleming Engines we believe this to be unnecessary, since our superior governor design, by slight adjustment, is capable of unusual speed variation. Such devices are usually required in other practice, but in our own it is looked upon as a convenience rather than a necessity, a large number of Fleming equipments being in satisfactory operation without them. It is sometimes, however, a convenience to centralize speed control and hence we are fully prepared to furnish several well-designed methods of accomplishment. There are offered three general forms, the selection depending usually upon the range of variation desired. They are classed as the Mechanical, being a hand-wheel device, mechanical, purely; the Electrical, by which control of the several units may be held at the switchboard; and the Combined, which embodies both means, intended to be operated primarily at the switchboard, but which should the attached motor fail from any cause, may be mechanically operated by hand at the engine. This latter is considered by us the best method and is usually recommended. For special services, as in speed change for Centrifugal pump service and for various plants where peculiar conditions prevail, we are also prepared to furnish modified types of special control.

Not a Necessity but Rather a Convenience

Three Substantial Devices

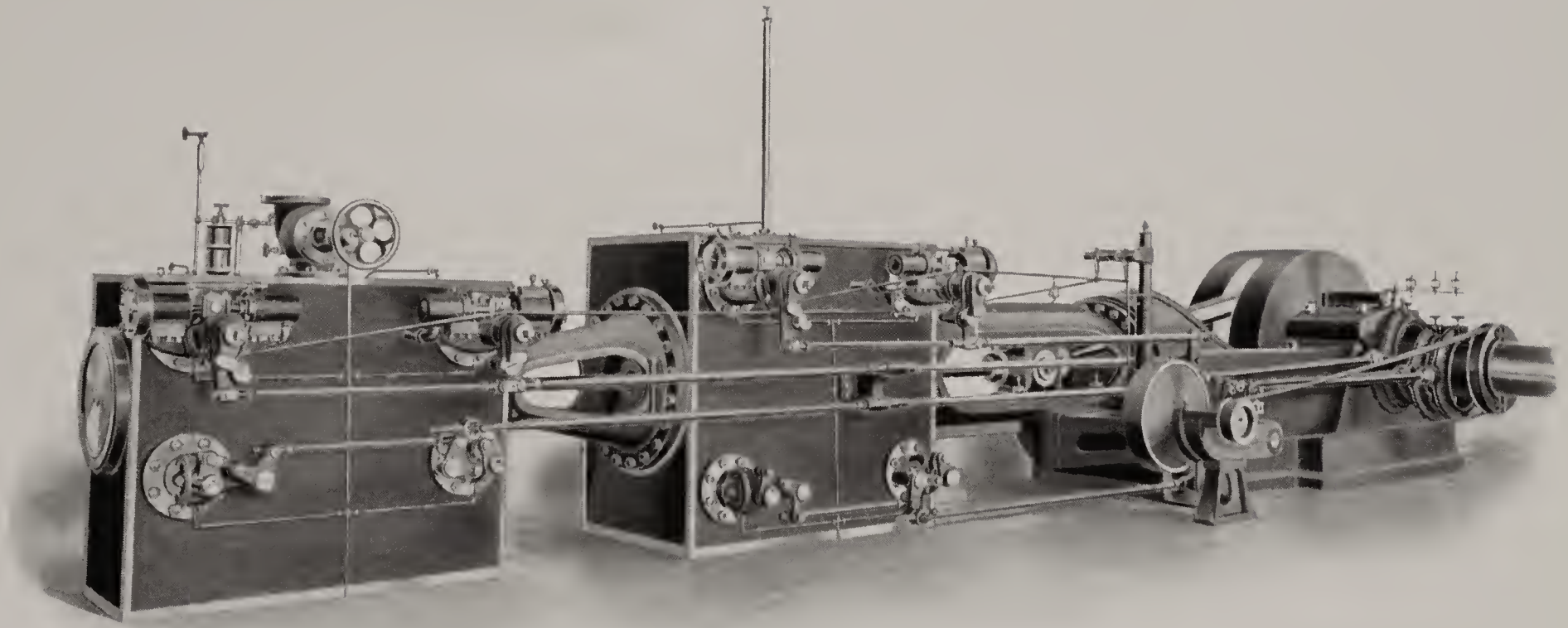

FIG. 62. GENERAL CONSTRUCTION FLEMING ACCELERATED VALVE GEAR ENGINE. TANDEM COMPOUND—Rear View.

THE FLEMING LONG-STROKE (CORLISS) ENGINE

THE Fifth Type of the System—

THE FLEMING LONG STROKE CORLISS ENGINE

We illustrate this type of engine for two purposes: First, to show good faith in acknowledging our mistakes; second, to prove by both inference and demonstration that we have honestly earned the serious commendation which many of the foremost engineers have given the products of this Company.

In our last publication (1899) describing the inauguration of a system of engine building, we placed this fifth type in the highest grade of both power and efficiency. At that time, and for some time subsequent, this was historically correct and certainly appeared consistent. But an unusual comparison of two principles was being enacted in the same establishment and plainly without prejudice. After having manufactured a number of these long-stroke Corliss Engines with their nice refinements in improved accelerated, steam-driven, Corliss valve gear in which many thousands had been invested in patents, drawings, patterns and test it was found, frankly to our surprise, that in spite of its nicety, its best results could be outdone and its elaboration thereby unwarranted. The short-stroke, quicker acting Fleming Engines, developed and tested under the same hands, without half the complication of valve gear, more compact, positive and self-lubricating, gradually forged ahead on every point, leaving this beautiful example of an older principle without excuse for existence. This Company made frank representations at the *outstart* of the apparent advantage contained in a fine example of a long-stroke "Corliss" Engine, supporting it with both money and talent, only to be forced to realize that long-stroke is a mistake.

An Unusual Opportunity for Unbiased Comparison

The Fleming Short-Stroke Engines Proved by Test Superior

LONG Stroke vs. Short Stroke

WHAT IT MEANS IN MODERN ENGINE PRACTICE

No one can doubt, however careful his analysis, that the long-stroke Corliss Engine built for forty or fifty years, and pored over by hundreds of our best engineers, has exhausted its limits of efficiency. No further improvement remains possible.

It then becomes necessary to turn to a new design in which to incorporate those conditions not possible in the older practice and by means of which to make new records. Careful tests have been made in Europe and now in our own work, which go to show conclusively that improvement in speed will reduce losses to which past designs are subject, identical engines being tested in exact parallel *except* at different speed, showing marked economy gained.

Better Speed Now Proves Better Efficiency

Bushed valves of *three ports* show better steam distribution.

Centrifugal Governors show gains under variable loads and pressures. Simplification, due to new designs in valve gear, combined with better speeds, shows reduced frictional losses. These vital points are no longer subject to adverse prophecy or opinion, but are proven from actual tests at hand. The results now apparent, therefore, lead us to state that the long-stroke Corliss Engine, with fly-wheel governor and elaborate cut-off device, is outclassed not in opinion, but as a result of test. Decidedly better efficiencies are now obtained by our new short-stroke wheel governing engines at full load, while efficiency curves show even larger gains when load and pressures vary as in almost all cases.

Logical and Historical Conclusions

If, then, these are facts (and our tests are now both numerous and authentic) there can then be no doubt that our latest offerings

are of the greatest interest to engineers and purchasers, and we predict surprise from those to whom this modern class of Fleming Engines is not fully known, when our records of accomplishment may be presented. It must be remembered that we unqualifiedly guarantee that these engines are *highly durable.* The design, materials and workmanship being such as to have rendered this beyond all doubt, while lower cost in foundations, floor space and generators, are additional advantages gained in their adoption.

We have repeatedly won premiums where guarantees were doubted and were supported by a clause of bonus or forfeiture and have no record of failure. Professors Carpenter and Deitrich, of Sibley College, Cornell University, and Professor Spangler, of the University of Pennsylvania, have conducted tests of corroboration. Copies of these will be gladly furnished upon request.

AS TO REPAIRS

In considering the repair account of valuable machinery such as efficient prime mover, the very first point is, without question, to make sure that the best quality of workmanship and materials are employed in the first place. No matter how carefully such machinery is handled in operation, first cost savings at the expense of quality, will prove in the end more expensive. We believe it has been made clear that the proper quality does exist in machinery of our manufacture and the best proofs lie in the fact that after taking account of nearly 9,000 engines of our make, and all repairs furnished for them, the total has been found to be less than 1 per cent. per annum of their first cost. Many records show at least 10 years of regular service without a single repair of consequence having been required. In designing machinery we particularly endeavor both to reduce necessity for repairs and at the same time so construct that renewals are of a practical character.

Workmanship and Materials Vital Elements

This means ability to promptly furnish new parts from a complete system of *interchangeable gauges* for interchangeable parts, a full record of other parts from *micrometer measurements* and a very comprehensive *system of pattern numbers.* All this, if honestly and faithfully done, means much to an old customer, when prompt response means the avoidance of expensive interruption to his power service. In ordinary renewals a simple reference to the engine number (found on the top of the engine frame) and a statement of parts desired, will usually bring exceedingly prompt service and shipment.

Prompt and Accurate Renewals

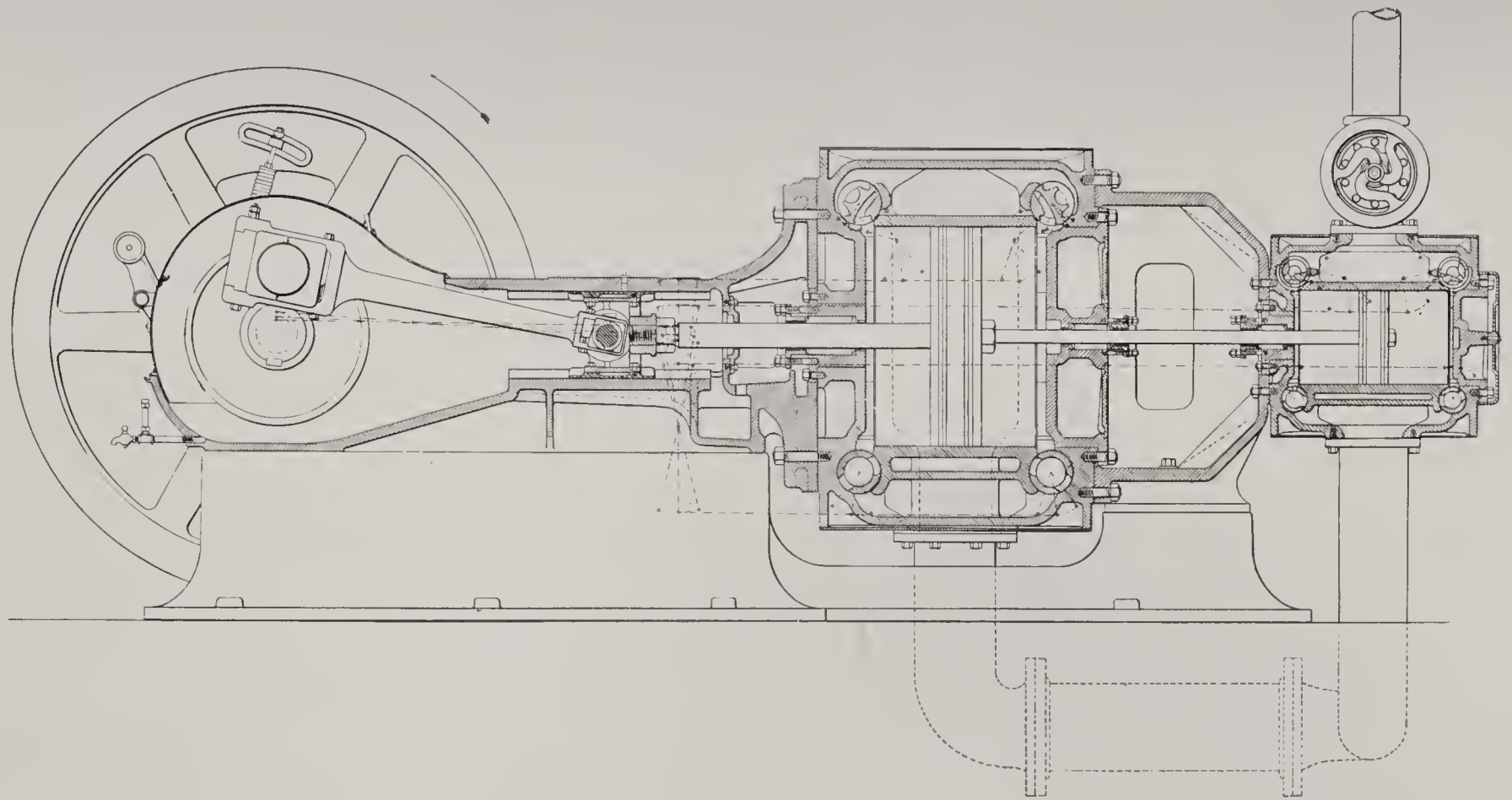

FIG. 60. SECTIONAL ELEVATION OF HARRISBURG STANDARD FOUR-VALVE TANDEM COMPOUND ENGINE.

THE FLEMING FOUR-VALVE COMPOUND ENGINE

GENERAL Instructions for Operating Fleming Engines

So much depends upon the skill and judgment of the engine operator, that it is manifestly impossible to give rules other than of a general character. We, therefore, suffix the following suggestions for the convenience of operating engines:

After the engine has been properly erected, and all piping correctly installed, the bed should be thoroughly cleansed inside, and a good quality of machine oil poured into the reservoir beneath the crank, until it is just in contact with the crank disc. Renew the oil for a few days.

In Starting

The best oils obtainable are the most economical, and, therefore, the purest. Mineral machinery oil and the heaviest grade of cylinder oil should be used.

The engine should always be thoroughly heated up and all drains left open before starting. This simple precaution may save a complete wreck of the finest machine possible to build.

All working parts of the various Fleming Engines are provided with adjustment for wear, and their simplicity of design renders further instruction unnecessary.

One precaution often overlooked is in making adjustments, to be sure all bearings are free to avoid heating and cutting, if not actually melting of the babbitt metals. A noise means deterioration, and if sought out and corrected early, will save both that particular damage and possibly a greater one later.

In Operation

The governor used on all the engines built by this Company and described under a separate heading is easily adjusted for small changes of speed by changing the spring tension, a greater tension increasing the speed.

All valves are adjusted before leaving the shop and to pro-

vide for re-adjustment they are trammed or otherwise marked. These marks will be explained upon request when shipped. We are always glad to give any information to operating engineers that will in any way assist them to properly care for and maintain a quiet, creditable running engine, and it is quite desirable that one of our erecting engineers be arranged for in order to allow of explanation to the intending operator. With each engine is furnished a bulletin which gives further instructions in greater detail. This bulletin will accompany the shipment and is a great convenience to the operator.

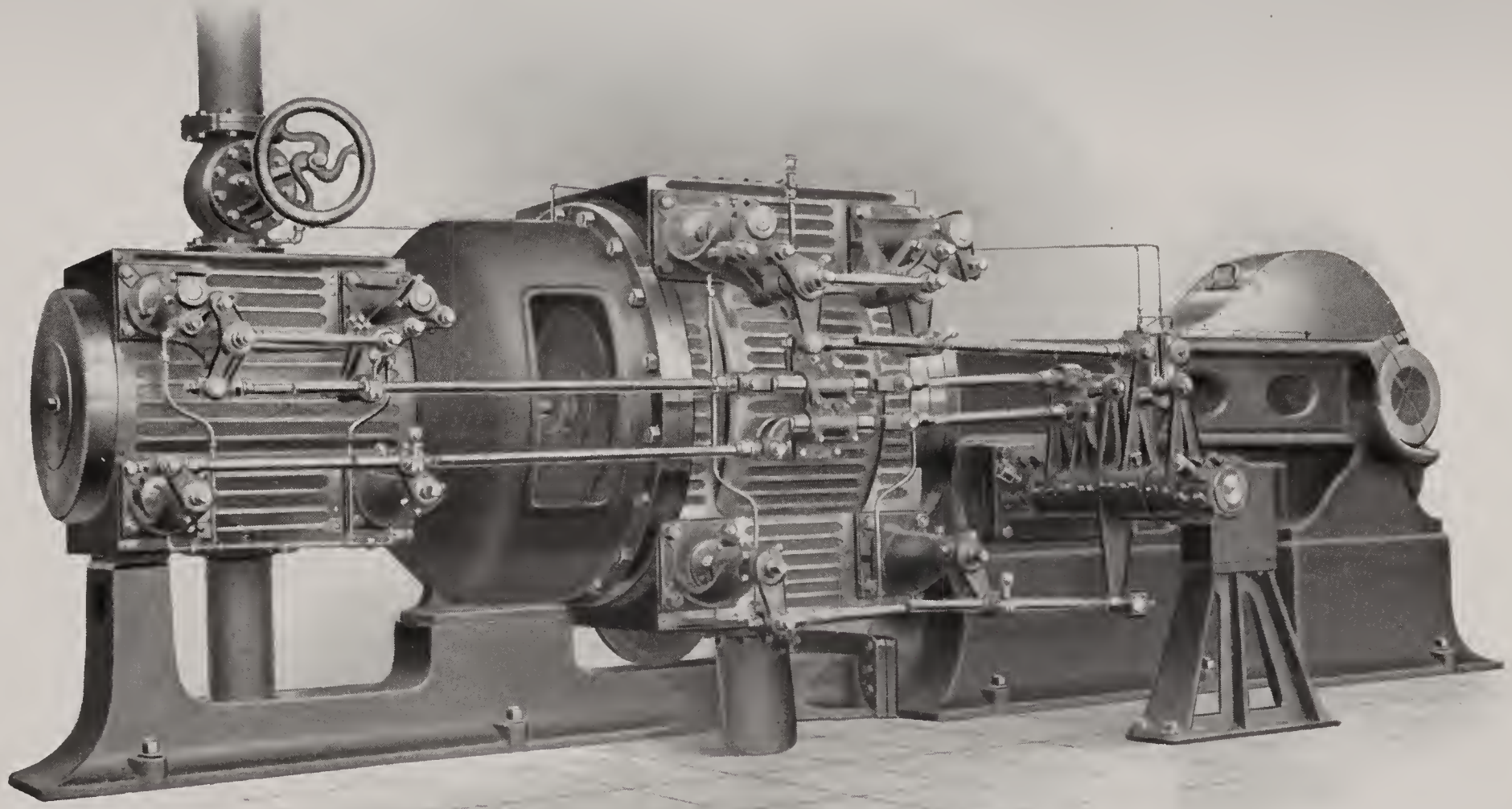

FIG. 59. GENERAL CONSTRUCTION FLEMING FOUR-VALVE TANDEM COMPOUND ENGINE.
Rear View. Showing Valve Gearing.

THE FLEMING FOUR-VALVE TANDEM COMPOUND ENGINE

SUMMARY of Conclusions Regarding Fleming Engines

Under the several headings describing the Fleming System of Engines we have earnestly endeavored to so carefully describe the character of designs, the use of only the safest and most durable materials, the evident superior efficiencies which are not only accomplished, but maintained, the policy of careful avoidance of misrepresentation and *the building of machinery in the purchasers' interest,* that a still larger clientage will result as an incentive to continue improvement on our part.

From the care used in selecting competent and trustworthy representatives, through the spending of our customers' money in engineering talent, materials, machine work, labor and testing to the tendering of our machinery for acceptance we pledge to you freedom from adulteration, fidelity, our best talents and no subterfuges.

Engine building and engine history differ more widely than many suppose from lines fancied to be generally parallel. In machine tools, for instance, close comparisons for durability and efficiency are always possible, if not unavoidable, so that honest builders are soon known. On the other hand, few engine purchases are followed into history, and still fewer are capable of competitive comparison as an investment.

It should be plain, therefore, that in engine buying rather more than in any other direction, since there is ever the temptation to cheapen manufacture because detection is remote, and there exists a "trade" demanding low prices to save profits in contracts taken too low for good work, offerings baited with first cost savings should be given a wide berth. Our 25 years' experience prompts the advice: "The best is none too good in the long run."

FLEMING STEAM POWER PLANTS

Profiting by our observations in steam plant construction, we strongly recommend, where at all practicable, to invite from two or three first-class manufacturers' specifications and proposals for complete contracts, based upon guarantees for net results in coal or cost rate per unit of power. This method relieves the purchaser of an immense amount of detail, guarantees a result upon which the operation of his project may be based and weeds out a class of incompetent bidders in detail whereto the usual disappointments can be traced.

This Company employs an engineering corps of the highest grade—technical men with practical experience—through whom and by means of the known capabilities of our own power factors we are enabled to make a complete proposition, based upon guaranteed net results in cost of operation, which will be found at the very top of modern attainment.

Fleming Power Plants of our recommendation and quite within frequent environment, are designed and guaranteed to operate at even less than one pound of good combustible per horse power hour, and a feature of especial advantage will be found in that even at varying loads and pressures this rate will fluctuate less than in any other kind of power. It is, perhaps, unnecessary to state that these results are scarcely paralleled in any establishment, and we invite those interested to cordial inter-communication upon steam power undertakings. We consider, since such opportunity is available, that purchasers will surely find the "splitting up" of power factors and the attempt to forge a chain of guarantees, a mistake, and earnestly ask serious consideration of our Complete Plant proposition.

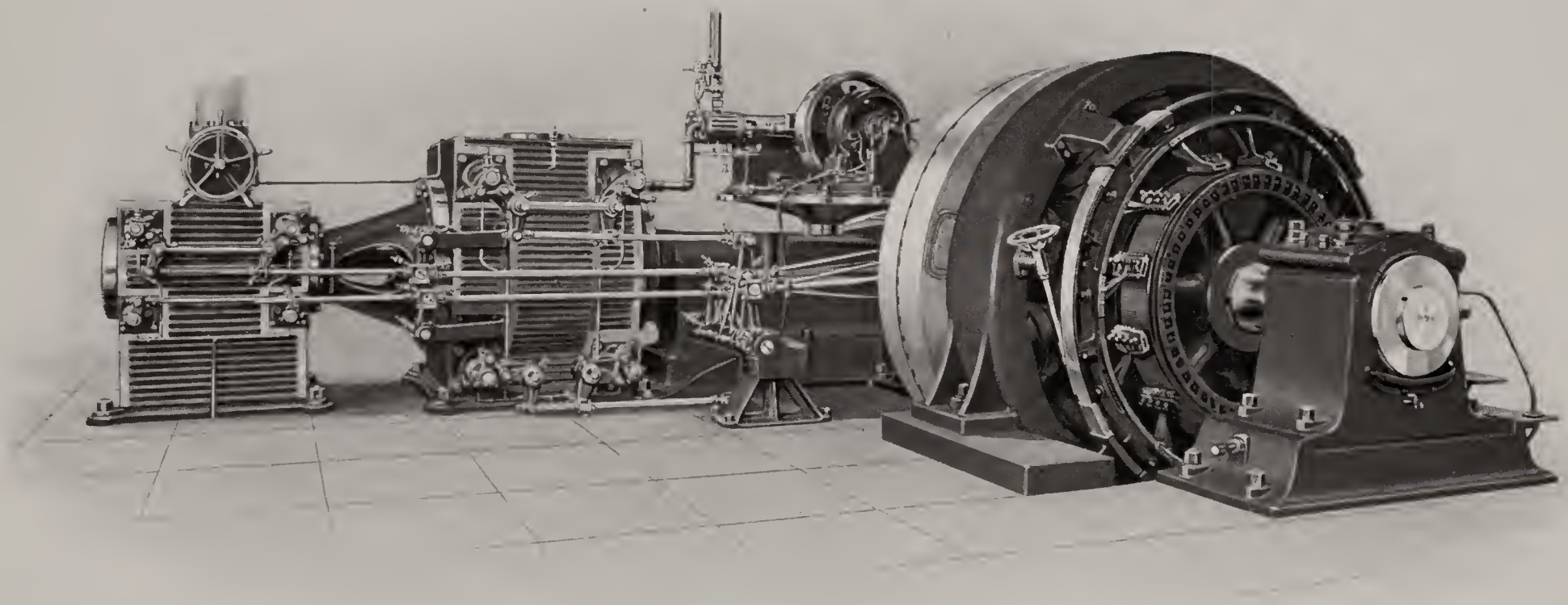

FIG. 90. GENERAL CONSTRUCTION FLEMING FOUR-VALVE TANDEM COMPOUND ENGINE.
Direct Connected Style, Rear View.

LOUISIANA PURCHASE EXPOSITION ENGINES.

NOTE: Particular attention is directed to the small Fleming single-valve direct-connected Engine, superimposed upon the main engine frame, and mounted upon a base plate to show remarkable balance.

THE FLEMING FOUR-VALVE TANDEM COMPOUND ENGINE

THE FLEMING STEAM TURBINE

Lasting success in manufacturing lines is attained only through the persistent policy of furnishing the right machine, honestly built, for the proper place, at a fair price.

The statement has correctly been made that over 50 per cent. of prime mover installations are not the best that could have been selected for their particular service.

These, in short, are our reasons for adopting a "system of prime movers," enabling us to offer the best machine possible, everything considered.

Steam turbines have entered the field of prime movers; we have, therefore, turned the searchlight of investigation upon them, examining most carefully the several types as manufactured both in this country and abroad.

Besides this we have also resorted to a very extensive series of experiments, to determine the more exact underlying principles involved in correct design.

Not only must the thermodynamic laws governing velocity and expansion of steam, be clearly understood in order to generate with the highest possible efficiency the kinetic energy of velocity, with reduction of pressure, but similar laws to those governing the efficiency of water turbines and propellers must be intelligently applied to the conversion of this energy into useful work.

The form of nozzles, guide blades, wheel buckets, spacing and length of buckets, velocity of wheel periphery and the relation of these parts to one another, are controlling factors of design.

This most complete and thorough investigation has covered a period of several years, resulting in taking up the manufacture of steam turbines, thus adding an additional type to our system

of prime movers, and placing us in a position to offer such machinery as is best adapted to each case.

It has become obvious that the steam turbine cannot supplant the reciprocating engine for general use; in fact, not a few installations already show unwise discrimination. We do believe, however, that it will ultimately find the field for which it is specially adapted, and be quite extensively used.

In placing the "Fleming Steam Turbine" on the market we offer a machine based on correct thermodynamic and mechanical principles, the result of a great deal of investigation, experimental research and a most complete study of the art up to date.

Economy, reliability, durability, accessibility and simplicity are prime factors of its construction.

We invite your attention to its merits, and suggest particular attention to our special bulletin, which will give detail information, and will be gladly sent upon request.

Recognition of Merit

Wherever the FLEMING ENGINES have been entered for comparison with the World's best products, there has followed the Award of Distinctive Superiority

Exceptional Recognition of Accomplishment

That this marked distinction of honor, conferred for faultless service, in addition to the gold medal of highest award by a Jury of Engineers whose experience and competence is unquestioned, should rest only upon the Engines of this Company may be considered deserving of especial consideration.

FLEMING SUPERHEATERS

MANUFACTURED UNDER THE PATENTS OF PROFESSOR WATKINSON, GLASGOW UNIVERSITY, SCOTLAND.

History shows that we are striving to supply Engines and Power Plants of the higher efficiency. The high efficiency of Fleming Engines is well known amongst steam users. The Four-Valve type in particular has now far excelled the modern improved Corliss construction with releasing gear, as well as the best results to be found from the steam turbine. Such engines leave little to be desired in a prime mover, unless through some outside medium, fuel itself may be further saved. Hence we have turned our attention to the possibilities of superheated steam.

In introducing the Fleming Superheater we are not experimenting nor expecting our customer to experiment. For several years Messrs. Mechan & Sons, Scotstoun Iron Works, Glasgow, Scotland, have applied it very extensively to all types of boiler for both land and marine service and with remarkable results. Its ready adaptability to any type of boiler and for any service, where superheated steam is desirable, makes its application almost universal.

Universal Application

The simplicity of these superheaters is at once apparent from the illustrations. We are enabled to place a distinctly high-grade superheater on the market at a moderate price, and with certainty of a fuel saving so great as to attract the prompt attention of the keenest investor.

A FEW FACTS ABOUT SUPERHEATED STEAM

When steam is superheated its volume is greatly increased at the cost of a comparatively small expenditure of heat.

Highly superheated steam in an engine cylinder acts similar

to a perfect gas, so that cylinder condensation is practically eliminated, avoiding, therefore, one of the greatest sources of loss.

Leakage past piston, through valves and pipe joints is *very much less* with superheated than saturated steam. Good authorities claim leakage with superheated steam is less than five (5) per cent. that with saturated steam, so that increased economy is derived from these three sources, viz.: increased volume, reduction of cylinder condensation, and reduction of leakage.

Experience with superheated steam has shown that by the simple use of a good grade of mineral oil no difficulty is experienced with lubrication. Animal fat or vegetable oils tend to decompose under high superheat. Temperatures, however, are much lower than in gas engines where lubrication is satisfactorily accomplished. These facts seem not generally appreciated.

There is *absolutely no danger* of engines being wrecked due to water, when using superheated steam, if the engines are properly drained and warmed up before starting, so that separators, traps, etc., are unnecessary. This should be remembered in applying costs of installation.

There is much less friction due to flow of superheated steam in pipes than there is with saturated steam, so that they may be considerably smaller. Twenty-five per cent. may be taken as a rough figure. This further reduces the first cost of the superheater.

Judicious Use of Materials

In starting up a new engine, or one with new internal wearing parts, highly superheated steam should not be used until the wearing surfaces subjected to steam have become glazed. The absence of knowledge or experience in these points accounts for doubts which have prejudiced many against a remarkable and consistent source for obtaining better economies.

In new plants the smaller capacity or number of boilers needed largely offsets the cost of the superheater itself, so that first cost or additional expense becomes an almost negligible quantity.

The accompanying illustration, Figure 91, shows a Fleming Superheater complete, ready for shipment. The drums are of extra heavy pipe and the tubes are drawn steel. The tubes are expanded into the drums. No cast iron is used in the construction of these superheaters, so that there is not the danger of headers cracking as in cheaper construction where cast iron headers are used.

Direction of Flow of Steam

Steam enters one end of the first drum, passes through the tubes to the middle drum, and from there through the second set of tubes to the third drum, and from which it passes to the engine.

The illustration, Figure 92, shows a sectional view of an independently-fired superheater. It will be noted that the direction of flow of steam as indicated by the arrows is such that the hottest gases come in contact with the tubes containing the hottest steam, and that the gases, just before entering the chimney, come in contact with the tubes into which the saturated steam enters. This arrangement not only makes a higher degree of superheat possible from the same amount of fuel, but reduces the gases to a lower temperature before passing to the chimney. The result is high efficiency.

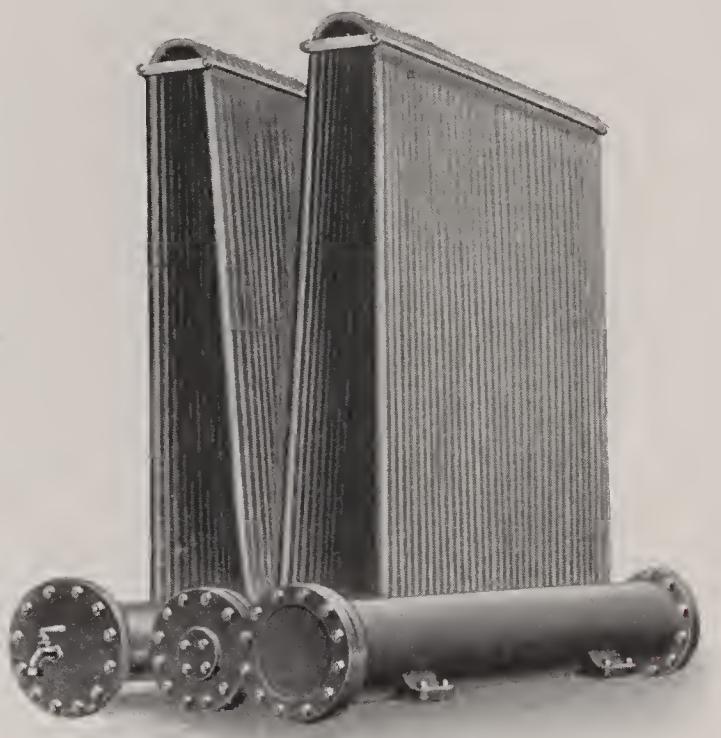

Fig. 91. General Construction Fleming Superheater.

Adaptability to All Styles of Boilers

The checkered brickwork between the furnace and the tubes

forms a heat regulator, so that when the firing door is open the superheater cannot act as a condenser. This is important.

Superiority in Design

While these illustrations show three drums with two sets of tubes, making a construction of an "M" shaped form, in some cases these superheaters are made with but two drums and from one to four rows of tubes, all of which are expanded into each header in the form of an inverted "V." It can readily be seen how well adapted this construction is to a variety of applications; it can very easily be applied to any kind of boiler, whether al-

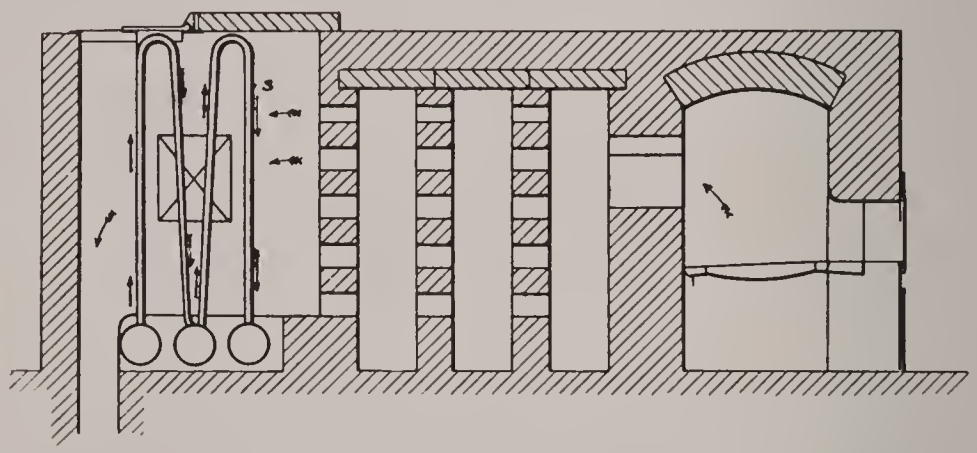

Fig. 92. Sectional View Independently Fired Superheater.

ready installed or new, and will add very greatly to the capacity of the boiler. About *twenty-five per cent. less boiler capacity* is required where these efficient superheaters are used. Waste gases from boilers or furnaces, oil, wood, coal or gas may be used as fuel for Fleming Superheaters. It should be noted that all joints are kept out of the direct flame. No water can stand in the tubes.

Estimate of Cost and Guarantee of Savings

A distinctive feature of Fleming Superheaters lies in their superior economy over all other devices, due to their unusual construction which is protected by the Watkinson Pat-

ents. Their superiority in this respect has been demonstrated many times by actual economy tests. We guarantee *higher efficiency* with *less heating surface* and *less* cost of installation than any other superheater on the market.

If you will send us your inquiry with full information, we will be pleased to carefully investigate your case and make you a proposition with definite guarantee. We suggest writing us for special Superheater Bulletin, giving further details. We fail to see how it is possible for steam users to longer disregard the saving to be gained by the use of these superheaters, amounting, as it does, in some cases to as much as *thirty per cent. in actual coal,* and this with almost trifling consideration of net cost of installation.

Heretofore superheaters have shown some saving in *steam,* but the Fleming type reduces the coal account to a degree which, when realized, will surely be appreciated.

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